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ABSTRACT

The overall focus of this booklet is on planning for change that allows for integration of computers into articulated learning environments that will enhance the learning goal of students. The first chapter presents four major themes to increase the likelihood of combining computers and individualized instruction in schools: (1) a revitalized form of computer-assisted instruction (CAI); (2) the utilization of computers by students for their own learning goals; (3) the use of a comprehensive instructional management system; and (4) the willingness of educators to provide alternative educational environments in harmony with technology. Chapter 2 begins the discussion of CAI with a brief history and moves to the four levels of CAI that range from drill and practice to systems that create a model for each student and modify it as learning progresses. Chapter 3 presents a Student-Computer Integrated Learning (SCIL) model that shifts the focus from students being passive recipients to their use of computers as a medium for learning. This model makes extensive use of computer-based simulations. Ways to reorganize schools consistent with SCIL that would personalize an individual's educational experiences are suggested in chapter 4. In chapter 5, a 4-year training program, using the "coaching" model, is proposed for educators and administrators to transfer skills to the educational process. The last chapter describes the need for a sophisticated instructional management system--Educator-Computer Integrated Management (ECIM)--to keep track of the progress of each student. Three pages of references complete the booklet. (MLF)

COMPUTERS AND INDIVIDUALIZED LEARNING

This booklet is published by the International Council for Computers in Education, the United States and international professional organization for computer-using educators. ICCE is dedicated to improving education through computer use and to helping both students and teachers become more computer literate. ICCE publishes *The Computing Teacher*, a journal for teachers and for teachers of teachers. It also publishes a number of booklets and monographs of interest to educators. Write for a free catalog at the address given below.

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Computers and Individualized Learning:

Moving to Alternative Learning Environments

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Foreword

The ERIC Clearinghouse on Educational Management and the International Council for Computers in Education are pleased to publish this monograph for teachers and administrators who want to obtain maximum instructional benefit from use of computers in schools.

According to the cooperative arrangement, the book's preparation was funded by the ERIC Clearinghouse on Educational Management, which commissioned the author and edited the manuscript. The International Council for Computers in Education supervised the book's production and is also responsible for marketing and sales. Both organizations are announcing the book's availability to their respective clienteles.

The author, Richard J. Robbat, teaches for the Lexington Public Schools, Lexington, Massachusetts. He has also served as a public school administrator. He holds a bachelor's degree from Colby College (1964), a master's degree from Boston University (1967), and a doctor's degree from the University of Oregon (1984). The subject of his dissertation was "The Utilization of Computers in High School History Education," and he has also written about problem solving and computers.

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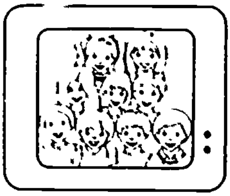


Chapter One

THE ESTABLISHED FRAMEWORK

"Would you like to write a booklet on the uses of computers and their applications to individualizing instruction?"

"What a great opportunity!" was my immediate reaction. Individualizing the educational experiences of students has been discussed, written about, abandoned, and recycled throughout the 145-year history of the public school movement in the United States. It is a model of education I have endorsed and practiced.

Yet if the available research is any guide, there exist few systematic efforts to emphasize individualized instruction in schools. In addition, the research on secondary school individualized systems of instruction (reviewed by Bangert and others 1983) showed "that instead of producing such dramatic effects, individualized systems at the secondary level yield results that are much the same as those from conventional teaching." There were no significant gains in achievement test results, critical thinking skills, self-esteem, or appreciation of the subject being studied.

Computers in education? Long before this assignment came, I wanted to find out who/what the enemy was, so I embarked on a year of sabbatical study and, subsequently, a leave of absence to find answers This led to my doctoral dissertation titled "The Utilization of Computers in High School History Education."

That computers have a role in education is beyond question. My students in secondary school history classes have used programs as tools in their studies. I believe computers can play a significant "instructional" role in education.

And what are the expected benefits of using computers in education?

> Better, more comfortable, and faster learning—since students will be able to use technology at their own pace and at their own convenience; opportunities to work with vastly richer materials and more sophisticated problems; unlimited, individual tutoring, and automatic measuring of learner progress (Kulik and others 1983).

Such was the prognostication in the early 1960s as summarized in the above source.

A meta-analysis of studies that included instructional uses of computers in grades six through twelve was conducted by Kulik and others (1983). Their analysis showed that "computer-based teaching raised final examination scores by approximately .32 standard deviations, or from the 50th to the 63rd percentile." Their analysis, however, pays scant attention to the extent to which the aforementioned "benefits" of the use of computers in education actually occur. The studies included in their analysis do not go beyond 1979. Also, most of the studies involved were limited to drill and practice, tutorials, and programming activities, though not by design.

Another weakness of current research is its neglect of the impact of microcomputers on learning. Very few contemporary studies demonstrate that computers are having a significant impact in education beyond the increased number of computers in schools and the proliferation of computer programming/literacy courses.

Therefore, you will not be reading in the pages that follow a summary of the virtues of a model of education based on combining individualized instruction and computers. Neither will this be an exhortative piece, one claiming that computers and individualized instruction are an unbeatable one-two punch that will revolutionize education.

In addition, you must resolve in your own mind the extent to which the objectives of individualized systems of instruction and computer uses for instructional/learning purposes can coexist with the goals of education.

Recently, an individual responsible for evaluating my teaching said, "You are the toughest person I have ever had to evaluate." During the subsequent discussion, the evaluator indicated there must have been at least 15 lesson plans in operation, students were continually leaving and entering the room, computers were being used in several different ways, students were working individually and/or in groups. Concern for tighter management was expressed. Were curriculum goals being met? Did I know where the students were going? I thought I was individualizing instruction, but what does that mean?

To define *individualized instruction* is itself a difficult task. Bishop (1975) neatly summarizes the difficulty with a series of questions about individualization. "Is it a new means for organizing a school? An instructional process? New technology? Teachers who deal with kids more personally? Or, is it a new instructional theory?" In response to the questions, Bishop suggests a number of elements that constitute individualized instruction:

- Organization
- Process
- Theory
- Teacher practice
- Instruction particular to each student

These elements will be examined repeatedly throughout this booklet. Certainly many of these elements are contained in the educational environment (and issues raised by the evaluator) that I was attempting to create.

With specific reference to my recent experiences, individualized instruction has meant providing each student with opportunities to use computers for learning within a particular subject area. Some students used *PFS: File* and *PFS: Report* for science and history projects. Others, including those with poor writing skills, used word processors to complete writing assignments. Graphics packages were available to use for course assignments that required diagrams and maps. More traditional "educational software" was available for students who needed additional help in mathematics and French. Students skilled in programming attempted to create software that might be used for a course in which they were currently enrolled, while some students were learning to program. In the context of the courses and students I had, an approach that personalized educational experiences seemed appropriate.

Traditionally, the primary goal of individualized systems of instruction has been to provide "teaching systems in which students work at their own rates through carefully designed units of course material with the help of study guides and diagnostic tests" (Bangert 1983). For now, it is sufficient to know that the original intent of computer-assisted instruction (CAI) was also that it be an individualized system of instruction.

Do the goals of individualized education and CAI coincide with the goals of education? The generally stated goals of education usually include:

- Develop the full potential of each individual
- Teach society's social/moral codes
- Transmit cultural heritage
- Provide manpower for economic growth

For our purposes here, the first goal is the most important one. Does one of your district's goals include reference to helping "each individual reach his or her potential"? If so, to what extent is that goal being fulfilled? Is the first listed educational goal regarded merely as a metaphor? Perhaps the last three goals dominate how schools and instruction are organized. If that is so, to what extent do the goals of education mesh with the goals of individualization and CAI? Does the use of computers for the purpose of satisfying the first goal really stand a chance in your district? In your school? As you read through the booklet, you are encouraged to keep these questions in mind.

Models for individualized instruction and computer-assisted instruction call for an adaptive educational system. Glaser (1972) states:

> An adaptive environment assumes many ways of succeeding and many goals available from which to choose. It assumes further that no particular way of succeeding is greatly valued over the other.

Do not most school districts pay only lip service to adaptive models of education, providing, instead, a fixed system for progressing through the schools? Perhaps, then, the marriage between computers and individualized education either is unlikely or is destined to be incompatible in present institutionalized educational settings. Before giving up, however, I will present four major themes for increasing the likelihood of a successful marriage.

The first is based upon the traditional but updated concept, computer-assisted instruction (CAI). In a CAI environment, the information to be learned is predetermined and programmed prior to use by students and educators. Computers are used as electronic information dispensers, replicating or improving upon the dominant means for dispensing information in our schools, the teacher. It is important to emphasize, however, that it is not the intent of present CAI systems to replace teachers.

A second theme is based upon students exploiting computers for their own learning goals: They can program computers in a variety of ways, and they can use a variety of applications software available for computers. Using databases, simulations, graphics packages, statistical packages, and word processors, students determine what information is to be stored, manipulated, and examined. I call this alternative model Student-Computer Integrated Learning (SCIL). Ultimately I argue that CAI is included within the SCIL model. CAI is discussed alone, in the next chapter, because of its dominant place in the history of computer applications in education.

A third theme in the booklet—and an important element of any model of education—is the use of an instructional management system. Education itself is an information-based enterprise. Students continually must process information. Teachers constantly are making decisions based on interactions among their students and between themselves and their students. Administrators develop approaches for scheduling each student and teacher, monitoring expenditures, and listing educational resources.

One of the primary uses and advantages of computers is their capacity for storing and manipulating large amounts of information.

Computer-managed instruction (CMI) is an important element in any attempt to individualize learning. The primary purpose for using CMI is to improve decision making in a school's and the teacher's instructional program, particularly as progress toward individualization occurs The technology allows us to have access to and use information in different ways. As Schiffman and others (1982) indicate, "There cannot be a rigid dichotomy between management and instruction—effective instruction cannot be discussed without considering effective management."

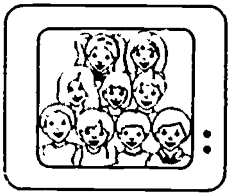
For the final theme, I borrow from Winner (1978) a concept of "technology" that I feel best provides a framework for attacking the issues of change caused by the introduction and uses of computers into schools Technology as a concept is complex; according to Winner, it has three characteristics:

- The "apparati" or physical devices (in computer parlance, "hardware")
- The "technique" or the skills, activities, and functions used by people to accomplish a task.
- The "organization" or types of social arrangements in a particular setting.

The issues of change are caused by the introduction of an "apparatus" into a particular setting, in our case that apparatus being computers brought into schools. Alone, the availability of computers in schools is not an indication that they will be used effectively or appropriately. The introduction of "apparati" in the past (for example, television) and their relatively minimal use is sufficient evidence.

The apparatus (in this case, computers) affects the "techniques" used by educators. In addition it will affect the "organization" of schools I will present some strategies for effectively addressing these issues in the context of providing "individualized" learning experiences for students.

Reaching the goal "to help each individual reach his or her potential" will *not* be achieved primarily by the use of computer technology Instead, that goal will be attained to the extent you and your school district are willing to participate in a systematic endeavor to provide alternative educational environments *in harmony with* technology The primary issue is to help educators to change, not to change to computers in education. The issues of human change and computer use go hand in hand.



Chapter 2

COMPUTER-ASSISTED INSTRUCTION

This chapter examines four topics that are important to an understanding of computer-assisted instruction. The first topic explores the historical development of computer-assisted instruction. The second topic describes the levels of complexity of CAI based upon a more sophisticated understanding of instructional processes. That leads to an examination of attempts to increase the responsiveness of computers to individual learners. The last two sections of the chapter examine alternative CAI environments, including a model developed by WICAT and the use of computers for "problem solving."

CAI History in Brief

The programmed instruction movement of the 1950s provided "the intellectual environment that gave rise to the first generation of CAI systems in the early 1960's" (Nievergelt 1980). Computers supposedly provided the flexibility lacking in prior mechanical teaching devices. The line of reasoning among the early proponents of CAI, according to Nievergelt, went as follows:

1. Education is a labor-intensive activity.
2. Technology applied to other labor-intensive activities in the past had greatly increased productivity and cost-effectiveness.
3. With programmed instruction as a teaching strategy and the computer as a delivery device, a technology of education has finally arrived.
4. Hence, CAI will significantly improve education in the foreseeable future—that is, make it more effective and cheaper.

"Technological determinism" (National Science Foundation 1983) was the major concept that dominated the earliest applications of CA. The efficient and effective use of a technology occurred when a tool was used "to serve a single *best* purpose, rather than several purposes at the same time." As I first indicated at the end of Chapter 1, any application of technology is inexorably tied to social and organizational issues. The "technological determinism" perspective generally was used in "highly structured, hierarchical, bureaucratic" organizations, an apt description of most schools at that time. As Nievergelt's list shows, the goal of supporters of the new technology was to make education more efficient. Electronic page-turning replaced the manual page-turning of programmed learning. This limited perspective was short lived.

"... any application of technology is inexorably tied to social & organizational issues."

During the mid-1960s proponents of the computers-in-education CAI movement suggested that computers would have impact only if they were more *responsive* to individual students. With the idea of increased responsiveness in mind, CAI advocates were developing projects at a number of universities during this period: Stanford, Illinois, Penn State, Pittsburgh, Texas and Florida State, among others.

This new approach to CAI was significant because it was a departure from the "technological determinism" mode of thought that had dominated earlier CAI developments. According to Suppes (1966), computers could contribute to education in two important ways:

> (First) the computer makes the individualization of instruction easier because it can be programmed to follow each student's history of learning successes and failures and to use his past performances as a basis for selecting new problems and new concepts to which he should be exposed next.
>
> (Second) a computer . . . can provide daily information about how students are performing in each part of the curriculum as it is presented, making it possible to evaluate not only individual pages but also individual exercises.

These two proposed uses of computers served as the bases for CAI developments since the mid-1960s. (Suppes' article, published in 1966, is very important because it provides historical perspective about the CAI movement and a benchmark for evaluating where we are today.)

Three levels of interaction were the center of CAI experiments during this period:

- Drill and practice
- Tutorials
- Dialogue systems

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The intended purpose of drill and practice was to supplement the teacher-taught regular curriculum. Prior to each use of computer-based drill and practice, teachers would present the concept; then students would practice on the computer with activities related to the concept. Consistent with the goal of using CAI to individualize instruction, children could be given different sets of problems based on their past performances. This method is contrasted with textbooks and workbooks, from which students are given the same set of problems.

The second level of CAI, tutorials, was developed to assume the primary responsibility for teaching concepts. As early as the mid-1960s, light pens and spoken instructions were being used with elementary school children to assist in concept acquisition.

The third and deepest level of interaction developed during this period was called "dialogue systems." The purpose at this level was to develop actual (real time) interaction between the user and the computer. There were two hop for means to accomplish this interaction. The first was recognition of voice patterns by computers. The second was recognition of questions asked by students via a terminal. Even now the field of artificial intelligence has as one of its major foci that very problem. Both of these methods today still present challenges to the developers of computer technology.

During the 1970s two of the more publicized CAI projects were PLATO, developed at the University of Illinois, and TICCIT, developed by the Mitre Corporation. PLATO (Program Logic for Automated Teaching Operation) was developed as a multimedia system, with graphics, animation, audio, and networking capabilities. It had its beginning in 1959. TICCIT (Time-shared Interactive Computer Controlled Information Television system) attempted to integrate minicomputers with television—using learner-controlled software. PLATO is still very much alive. TICCIT still exists but has not been widely used. Although neither system enjoyed widespread dissemination, they symbolize a more enlightened view of computer-assisted instruction.

Levels of CAI

As Suppes and others were beginning to explore further the capabilities of computers for CAI, changes in perception about the nature of instruction were appearing. According to Kamouri (1984),

> A sort of paradigmatic shift in human learning has taken place over the last twenty years—away from a model based on stimulus and response associations to an approach that acknowledged the importance of complex information processing.

That appreciation for the complexity of the learning process has led to the identification and development of at least four levels of CAI.

Kearsley (1977) labels the four levels:

1. Response insensitive
2. Response sensitive
3. Idiographic
4. Student model

Response Insensitive CAI

At this level CAI is automated programmed instruction. When the program processes poor or incorrect answers from the student, it goes to prespecified conditional branching. The branching is based only upon the most immediate response of the student; patterns of past performance are not part of the response branching.

Response Sensitive CAI

This second level of CAI involves the selection of instruction based upon an assessment of performance as the individual moves through the sequence of instruction. An example is a tutorial program that adjusts the level of difficulty to constantly provide a challenge to the user. The "response sensitive" level is the first that appears to require computer technology.

Idiographic CAI

At this level of CAI, programs provide instructional sequences that have been determined by a variety of characteristics of learners. These characteristics are based on data about the students, including aptitude, district or age-group reading levels, interests, previous knowledge of subject matter, and personality. The programs contain rules that control the selection of the instructional sequence.

Application of CAI at this level becomes more complex. The difficulty is in predicting the relationship between the types, rate, and mode of presentation and an individual's performance.

Student Model CAI

The student model is the most sophisticated level of CAI. Kearsley describes the student model in the following way:

> A student model is a representation of the hypothesized knowledge state of the students as represented by a set of procedures. The system would create a model for each student consisting of procedures for the presentation of material and assessment of performance. As learning occurs, the procedures are modified, thus altering the student model itself. . . . In principle the system could diagnose deficiencies in learning strategies/tactics and be able to indicate these to the student. It would also be possible for the student to state preferences for types or modes of instruction via procedural definitions.

Presently, very little available evidence indicates CAI application efforts in schools go beyond the first two levels.

Several reasons govern that state of affairs, in my opinion. First, few educators understand the extent to which computers can assist the learning endeavors of their students. Second, educators' vision of computer use is limited to present patterns of school and classroom organization. Third, educators have placed few demands on vendors for coordinated hardware/software efforts that enhance use of computers with a "student model" in mind.

System Responsiveness

The goal of computer-assisted instruction system developers since the mid-1960s is one that emphasizes system responsiveness. As defined by Kamouri (1984), ***system responsiveness*** is "the degree of learner-computer interaction and the adaptability of the program to differences in skill or knowledge levels among students." The oppor-

System responsiveness is "the degree of learner-computer interaction and the adaptability of the program to differences in skill and knowledge levels among students."

tunity to take advantage of CAI methods that have a high degree of system responsiveness (for example, idiographic and student model characteristics) is made possible by the research and development of "knowledge-based" systems.

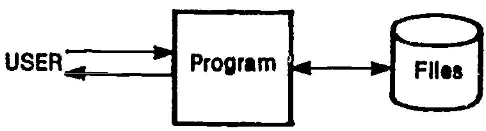
In a beautifully developed explanation of knowledge-based systems, Sowa (1984) begins with a quote from Seneca *(Letters to Lucilius 33)* that differentiates between remembering and knowing: "To remember is to preserve something committed to memory; to know, by contrast, is to make each item your own, not to depend on a model and to be constantly looking back at the teacher." The characteristics of a knowledge-based system, according to Sowa, are described by that quote:

- Knowledge is more active than rote memory.
- Knowledge does not depend on a fixed model, but can be applied in new ways to novel situations.
- A teacher may be necessary to impart knowledge, but the knower should be able to use it without external guidance.

The first three levels of CAI, and the programs that contain them, generally are based on a fixed set of instructions (see diagram 1). The student model, requiring a knowledge-based system, adapts to changing circumstances (see diagram 2). The two diagrams represent the differences in the system responsiveness of the first three levels of CAI as compared to the student model.

A knowledge-based system, therefore, "keeps track of the meaning of the data and performs inferences to determine what information is needed even when it has not been explicitly requested" (Sowa).

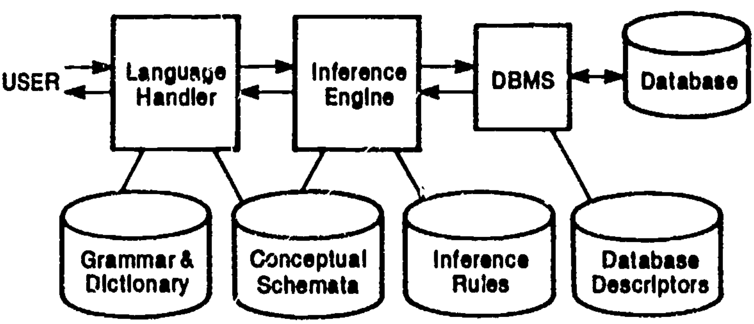
At this point, it becomes increasingly evident that one cannot separate a more sophisticated concept of CAI from computerized management systems. Returning to the remark of Schiffman and his colleagues: "There cannot be rigid dichotomy between management and instruction—effective instruction cannot be discussed without considering effective management."



A conventional program

Figure 1.

Source. *Conceptual Structures. Information Processing in Mind and Machine* by John F. Sowa. p. 278.



A knowledge-based system

Figure 2.

Source. *Conceptual Structures. Information Processing in Mind and Machine* by John F. Sowa. p. 278.

Types of CAI Environments

There are two basic types of CAI environments. The first is what is common to most schools. Educators use stand-alone microcomputers and subject-matter-specific software. The software tends to be response insensitive—that is, drill and practice—with an emphasis on basic facts. Some of the software is tutorial, with a limited amount of branching (response sensitive).

The second environment uses a totally computer-based system. This environment includes the first three levels of computer-assisted instruction. One example of such an environment is the system developed by WICAT in Orem, Utah. WICAT offers a laboratory setting with 30 terminals, linked to a microcomputer. Presently their computer-assisted instructional materials focus primarily on elementary school reading and math skills, though they are rapidly increasing the availability of courseware in other subject areas and for secondary schools.

WICAT has included three elements in several of its CAI packages: mode of operation, "individualization," and "course management options." The *mode of operation* includes three types of student-computer interaction, giving teachers and students the opportunity to make decisions about the nature of the instruction that will follow:

- "Placement mode" (diagnostic tests)
- "Practice mode" (student-elected ungraded practice sessions)
- "Progress mode" (computer-sequenced lessons)

The second element, *individualization*, includes using the microcomputer to:

- Track individual performance
- Direct students to subsequent lessons
- Provide lesson help sequences

The third element, *course management options*, includes:

- Generating student (class and individual) progress reports
- Resetting lesson levels for individual students

One of WICAT's selling points is the availability of a comparatively high degree of system responsiveness, in essence a well-developed computerized management system. One of WICAT's major projects is the development of a computer-based student learning style inventory. The goal is to interrelate the results of the inventory to the various modes of presentation in a particular skill/subject area for each student. The project is significant because, if successful, it will provide a more comprehensive idiographic level of CAI and a step closer to an attempt at the student model level.

At the same time (since the mid-1960s) attempts have been made at creating more sophisticated CAI courseware, there has been also a movement to improve the problem-solving capabilities of students. Critics of CAI claim that the use of computers for CAI purposes limits the employment of computers. Computers have been developed to give their users more powerful learning applications than drill and practice. The claim is made that it is more important to give students the ability to solve problems than to reinforce a type of learning that stresses only the learning of facts.

"... it is more important to give students the ability to solve problems than to reinforce a type of learning that stresses only the learning of facts."

Problem Solving

In the last two decades, *problem solving* has become a popular term. Like many terms in education (for example, individualized instruction, computer-assisted instruction), problem solving lacks a clear definition. Is problem solving a method of learning? Is it an outcome of learning? As Chiapetta and Russell (1982) indicate, "An established and commonly acceptable definition for problem solving is not shared among educators." Branca (1980) lists three interpretations of problem solving: goal, process, and basic skill. The literature includes many synonymous terms for problem solving: analytical thinking, critical thinking, reflective thinking, scientific thinking, discovery, and inquiry.

Procedural Modes of Thought

According to Shaftel (1971), the basic assumptions behind any problem-centered curriculum include the following:

> [that] human beings are active, striving organisms, capable of self-direction; and that it is the nature of man to be a satisfaction-seeker and problem solver.

Yet many of the proponents of problem solving argue that problems are solved by following systematic, procedural modes of thought. Hunter (1983) describes a *procedure* as a "specific set of instructions that must be carried out in exactly the specified sequence." She goes on to justify the use of procedures.

> We need procedures in order to handle information in systematic ways, to learn to complete tasks, and to solve problems. We need procedural thinking skills whether we are using a computer, a calculator, pencil and paper, or any other tool to aid in the process.

Taking another tack, Straus (1969), in defining *strategy* as a "process, operation, or plan that can be performed on the problem state to help us move it towards a resolution or solution," suggests an important facet of procedural thinking too often ignored:

> A strategy takes you away from neutral ground towards one corner of the problem. And for each direction you can go there is probably an opposite direction that might be equally helpful, if not several.

A strategy, then, causes two things to happen:

1. It gets the individual to move mentally; and
2. It commits the individual to a direction for a certain period of time.

This perspective encourages the individual to be aware of and adopt a more flexible approach to any problem-solving endeavor.

Problem Solving and Microcomputers

With the advent of popular use of computers, procedural thinking is being proposed as the panacea for more effective problem solving. Hill (1983), for example, suggests:

> The most profound point to be recognized by schools and teachers is that microcomputers not only aid in accomplishing established skill and concept objectives but also they create new needs and goals for schooling. These goals relate to particular thinking processes (organizational, systematic, and analytic) and the skills of logic and communication that enable the student to make use of the technology effectively to solve problems and to live comfortably and productively in an information society and information economy.

Hill goes on to claim that "the computer provides a unique tool to aid in the solution of problems."

As extensive as the literature is on the role of computers in education, there are but limited examples of using computers in schools for problem-solving purposes. Earlier research (Robbat 1983) examined problem solving and the use of computers in science, mathematics, and social studies education. Little research was available on the relationship between computers and problem solving in those curriculum areas, reaffirming the minimal impact problem-solving methods and computers have had on classroom environments. Few educators and educational institutions attempt, allow or provide for such an environment to exist. Megarry (1983) points out, "Only when educational technology becomes an integral part of the thinking of ordinary teachers . . . will it actually change what happens in the classroom and how students learn."

Recently, I have worked with junior high school science teachers who have used computers in some of their units of study. In one case, students collected data about twigs, entered that data using *PFS: File*, and analyzed the data using *PFS: Report*. Students asked questions about the data, questioned each other when variations occurred, and helped each other enter and analyze the data.

In another instance, students were using temperature, pulse, and response rate probes and analyzing the data from their experiments. Computers eliminated the drudgery of plotting graphs. Because the graphing of the data was faster, students were able to analyze it more quickly.

In both cases, the learning experiences of the students became more individualized as students conducted their own experiments. The classroom environment, as a result, became increasingly decentralized. Students having difficulty with more traditional approaches to the science curriculum were participating more positively and apparently learning more. I must emphasize, at this point,that curriculum objectives were followed and met.

The teachers began to realize that the use of computers can significantly alter the nature and sequence of their science curriculum. Students were going beyond the original intent of the lessons. The teacher observed students developing their own experiments, and, more importantly, asking "what if" questions. In the teachers' opinions, real experimentation and discovery occurred among all students.

A Mechanical Authority Figure?

The stated purpose of computer-assisted instruction systems is to use technology to personalize a school district's efforts to teach students a particular curriculum. The systems are constructed to anticipate a variety of instructional issues that occur as teachers proceed through their curriculum.

What educators have to decide is whether increased system responsiveness perpetuates a model of instruction that actually limits the power of computers to enhance the development of alternative learning environments. As Papert (1979) states:

> The teacher plays the role of an authority figure who prescribes the exercises and judges their performance, while the child . . . is also learning how to accept authority in a way prescribed by school and society. Replacing a human teacher by a machine changes nothing, except that perhaps it makes the process more effective by giving it a mechanical image that is in fact more resonant with what is really going on.

The implications of CAI are left for you to determine. A second approach to the use of computers, Student-Computer Integrated Learning, is examined in the next chapter.

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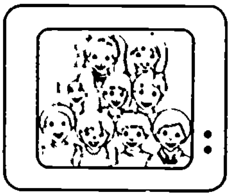


Chapter 3

STUDENT-COMPUTER INTEGRATED LEARNING

In 1970, the report to the President written by the Commission on Instructional Technology stated, "Technology can make education more productive, individual, and powerful, making learning more immediate; give instruction a more scientific base; and make access to education more equal." The report goes on to advocate the use of technology to reach instructional goals. In Olson's (1974) opinion the writers of the report overlooked or ignored an alternative application of technology.

For Olson, technologies "are not to be considered as means to preset ends but rather as a means for reconstruing those ends" because their uses allow expression and communication. Olson's view of technology is an apt description of Student-Computer Integrated Learning, whereas the thrust of the commission's report appears oriented toward (computer) technology, computer-assisted instruction. Certainly few educators to date have sought to "reconstrue those ends."

> The present patterns of computer use reinforce our tendency to place students in passive roles so that the organization of the process of learning is taken on by others. Education is viewed according to the Transfer Metaphor, which takes knowledge to be an object that teachers *insert* into the minds of their students (Garson 1980).

Though expressed in 1980, Garson's Transfer Metaphor neatly captur· ·he intent of advocates of computer-assisted instruction, given its origins and its practice in schools today. The focus of instruction is on the mode of insertion, that is, computers, rather than on the students.

Many educators are familiar with Taylor's (1980) oft-cited metaphors (computers as tutor, tool and tutee). They reinforce the technology-centered frame of reference educators are expected to assume in relation to computers (technology). A definition of each of Taylor's metaphors supports this point:

- Computer as tutor: computers used for instruction (CAI)
- Computer as tool: computers used as a practical utility
- Computer as tutee: computers used for programming.

The focus in each case is "computer as. . . ."

Shifting the Focus from Computer to Student

A purpose of education is to provide students with opportunities for learning. Goals and objectives in education are written in terms of *student outcomes* and include what students (should) learn. Should not the resources that are used to assist in reaching those goals and objectives have the same frame of reference? The applications of tools/resources/technologies, therefore, should be viewed in terms of students and the resources that they use to learn.

Originally, my intent was to change Taylor's metaphors, using students as the frame of reference. They were to read as follows:

- Student as tutor: students program computers
- Student as tool applicator: students use computers as a resource
- Student as tutee: students use computers as an instructional aid (CAI)

The metaphors—tool and tutee—were flip-flopped, and students became the focus of use of the tool.

I subscribe, however, to Kay's view:

> The computer is *not* a tool—that is a very weak characterization of the thing. The tools on the computer are the programs that make it into various kinds of levers and fulcra. The computer itself is a medium like paper—zillions of degrees of freedom, used in many ways that the inventors of it can't and don't need to understand, making a fundamental change in the way people think about the world (1983).

From that perspective, alternative labels for student-centered computer utilization that are more appropriate, in my opinion, include:

- **Student as designer:** Students develop programs to use computers as a medium for learning.
- **Student as practitioner:** Students select and apply programs to learning situations.
- **Student as receiver:** Students are given programs to use for instructional purposes (CAI).

The third category, student as receiver, has been discussed extensively in Chapter 2. As a discussion of the first two categories unfolds, please keep in mind that the categories are not mutually exclusive.

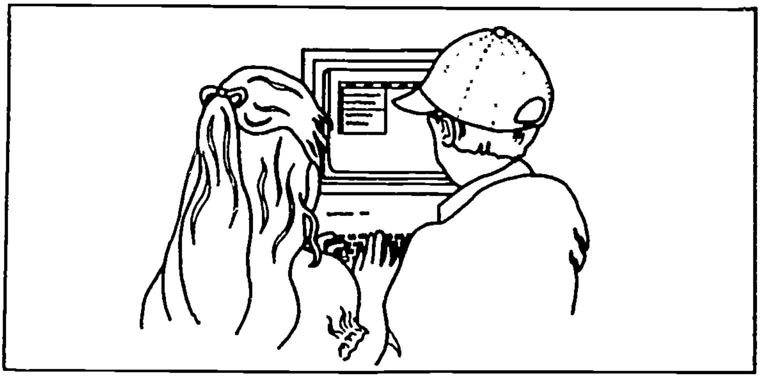
Student as Designer

As designers, students develop and write programs. Programming has several dimensions to it. The conventional concept of programming is to code in a computer language. In schools the three most popular languages are Logo, BASIC and Pascal. The primary use of computers in schools today is this dimension of student-computer interaction.

A second dimension of programming is to alter existing programs. As students become familiar with programming and the capabilities of computers, they should be encouraged to alter the coding of existing programs to fit their own purposes.

A third type of programming is to use authoring languages. An authoring language allows a person to develop teaching programs similar to CAI programs. Students could write, test, and modify the programs based on the reactions of other students. Various versions of PILOT provide examples of authoring languages that can be used in this way.

A fourth type of programming is the use of menu-driven programs. Students make decisions about how to best use a pre-existing program, based on the alternatives that appear as a "menu" on the terminal screen.



In all four cases the student is making decisions about how the computer will perform. The student, who has learning objectives to reach, designs programs for use of computers to reach those objectives. More importantly, students develop a frame of mind that emphasizes their control of the technology.

Turkle (1984) describes what she was told and what she observed as she explored the impact of computers on how people think about themselves and others. Her observations are important because they convey the unique features of a "programming environment" that foster both the individualization and socialization goals of education.

> In traditional school settings, book reports are presented to teachers who try to instill a sense of the class as community by asking the children to read them aloud to the group. In the context of children and programming projects, the sharing usually happens naturally. Children

can't do much with each other's book reports, but they can do a great deal with each other's programs. Another child's program can be changed, new features can be added, it can be personalized.

The focus has been shifted to students, and away from computers. Students use computers for a variety of reasons. One way of using the computer is to "program" it. As described above, programming can be viewed in several different ways. In each way, however, the student is programming the computer for specific reasons.

Student as Practitioner

Students have always used a variety of resources to assist them with their school-related work. Generally they have been limited, however, to books, whether they be text or library books. Beyond that, there has been limited use of tools in U.S. education. Goodlad (1984) comments on the use of tools in schools, based on the extensive research used for his publication, *A Place Called School*.

> An often-repeated purpose of educational institutions is to teach human beings to use the tools of our civilization. We were less than encouraged by what was provided to fulfill this purpose in the schools we studied. How did almost all of them manage to shield themselves so effectively from the technological revolution now well underway? The common absence of modern technological devices for learning in the classrooms we observed seems to convey the implicit, erroneous message that these have nothing to do with the educative process. The patriarch of the tools of schooling is the pencil, the matriarch is the pen, and the rest of the family is an assortment of crayons and plastic measuring sticks.

Students now fill notebooks and worksheets with information. They are asked to draw pictures, take notes, compute, write papers, gather data, hypothesize about and synthesize from information. Computer-based application programs—that is, packages—give students unprecedented opportunities and capabilities to gather, store, and manipulate that same information.

There are four different dimensions to students' use of application tools with computers. *In one dimension, application packages allow students to gather, store, and manipulate their own data, according to their own formats and styles.* (Isn't that part of what individualized education is about?) Such packages include the *PFS* family of software, *AppleWorks* and *LOTUS 1,2,3*.

A second dimension of student as practitioner allows students to develop their role as knowledge builder. As knowledge builders, students develop and discover processes for acquiring knowledge. One of the primary proponents of that role for students is Seymour Papert. Papert's Logo is the most widely used programming language in U.S. elementary schools today. Papert's intent was not to have Logo taught, with Logo curricula appearing in computer education journals and magazines for teachers to follow. A purpose of Logo is to provide an environment in which students build ideas about geometry and spatial relationships. A similar example is the "Geometry Supposer" used on DEC computers. The strength of this role is that it allows students to explore the capabilities of the software and to develop their own generalizations on which to build their own "new knowledge."

A third dimension of the role students play as practitioners is based on the "information demands" of students. Commercial data bases accessible by microcomputers and modems include CompuServe, The Source, and Dow Jones News/Retrieval. These commercially prepared data bases can provide students with up-to-date information, for example, on topics that are capturing headlines at any given time.

The use of computer-based simulations/models is a fourth dimension of the student's role as practitioner. Models (a process used to describe or predict relationships among phenomena) imply that what is observed and the relations among the observations are supported by theories. Also, there are several epistemological assumptions associated with simulations:

- A model deliberately is created to imitate an aspect of the "real world."
- The model is subjected to experimentation in an effort to understand the model's properties, forces, and behaviors.
- If the model is valid and understood because of experimentation, a truer understanding of the real world is an expected outcome.

Elsewhere (Robbat 1984) I discuss the role of simulations in history education. The principles apply to any field of study.

> Computer simulations provide a common environment and common variables yet allow students to make similar or different decisions. The decisions that students make while interacting with each other and the computer become the focal point for developing and comparing the decisions and models of decision-making they apply to those made by actual historical characters.

A key to the use of simulations is a system for keeping track of decisions that students make individually and collectively during the course of a simulation. The primary purpose is not "winning" or completing the simulation satisfactorily. Rather, the primary purpose of simulations is to examine the rationale for decisions that individuals and groups make during the course of the simulations. Their educational use is enhanced by having students keep records of their decisions. Some simulations require students to use charts to maintain records of the data they enter during the course of the simulations. In other simulations students record the results of their decisions on graphs. If no systematic process of decision record-keeping is used, an alternative is to require students to keep a log or "diary" of their decisions.

Computer-based simulations are powerful tools for teachers in an individualized education environment. They provide teachers with insights to their students' individual and group decision-making processes. With additional research students can compare their decisions to those of "real world" practitioners. The simulation "Three Mile Island" provides that opportunity. Furthermore, students will be able to compare their decision-making model to the model of the developer of the programmed simulation.

In environments where students are designers and practitioners, the relationship between teachers and students changes. That relationship becomes more of a partnership in learning as both teachers and students develop and explore tools that are appropriate to particular tasks. The development of these environments and partnerships has a significant impact on curriculum policies in school districts.

Computers and Curriculum

Student-Computer Integrated Learning (SCIL) places a premium on the process of learning and doing, and not on the process of teaching. Within this framework, the curriculum no longer forces the same data on the same students at the same time. In the traditional framework, teachers are faced with curricula guides that require coverage of a predetermined amount of material during the school year. That material must be covered without regard to the rate at which students master facts and concepts. Ability tracks and grades are devices employed by educators to enhance the achievement of curriculum objectives.

Yet, for the most part, the moving force in education, that is, the force moving children from grade to grade, is chronological age. Reaching and going beyond curricula objectives are not the moving forces in education.

The role of curriculum must be reexamined. It might be that computers will render obsolete curriculum as we know it. In Papert's (1979) opinion the penchant for drill-and-practice software and CAI systems of instruction

> reinforce(s) one more feature of current education, the concept of curriculum, which appears to most educators as inseparable from effective communication of knowledge. This drill and practice model raises to a higher power the idea that education without curriculum equals chaos.

Bowers (1984) is concerned that teachers no longer understand their craft.

Educational theorists and technicians have attempted to model the process of teaching on principles derived from the areas of industrial engineering and systems thinking.

The language of "learning outcomes," "performance indicators," "behavioral objectives" are metaphors that carry the image of a student being molded and shaped by external forces. While a pretense may be maintained that this language represents a more systematic approach to thinking about traditional educational values, the fact remains that the teacher's craft of transmitting the culture in a manner that encourages critical reflection is being replaced by the image of a production process that involves both the progressive de-skilling of the teacher and the manipulation of student behavior through a powerful reward system.

The traditional craft of the teacher can be rescued and strengthened by understanding the connection between the content area of the curriculum and how it will be recognized by the student.

Greater emphasis must be placed on understanding the nature of learning. According to Bowers, we must drop "the practice of thinking of education in terms of the root metaphor of a mechanical universe." Computer-assisted instruction (student as receiver) reinforces a mechanistic view of the world, as do worksheets and workbooks. Curriculum based on chronological age is another example of a mechanistic view of education.

With the SCIL model, education is viewed more in terms of how each person can design (or redesign) for personal use the tools that make computers function. In terms of our discussion here, the goal of SCIL is to provide educational environments that allow individual students to take advantage of the variety of tools and media that enhance learning. A perspective that encourages development of a SCIL approach enhances the growth of those environments. Some suggestions for developing alternative educational environments are discussed in the next chapter.

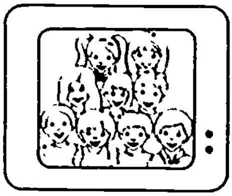
The Need for Individualization

Some people contend that the present educational system is already "individualized." Students are placed in homogenous groups based on achievement, aptitude tests, parent desires, motivation. Students use a wide variety of information processing skills. Some students have parents who assist them with their school work. Others rely on their friends, or work by themselves. Individual students have a variety of reading habits Depending on socioeconomic conditions, students experience a variety of environments and activities outside of school.

Yes, there is overwhelming evidence that each student has a greater variety of individual characteristics than we acknowledge in schools. Yes, individualized "educational" experiences do take place to a greater extent outside than inside a school.

One argument, however, dismisses the claims that schools are another example of individualization that students experience. Generally, an individual in a school setting is evaluated based on public knowledge. That is, teachers know the answers, and students are given grades based on the extent to which they can figure out the answers teachers already have. Usually there is only one answer, one curriculum sequence, one standard for evaluation.

The outside world is individualized to some extent. The inside world is not. SCIL offers a variety of environments and opportunities to allow for greater individualization inside. How that might be accomplished is discussed in the next chapter.



Chapter 4

A FRAMEWORK FOR IMPLEMENTATION

The purpose of this chapter is to present an argument that meaningful and appropriate uses of computers for instructional/learning purposes will occur only if educational leaders develop a framework for alternative educational practices.

Joyce (1974), writing in the context of communications media in general, anticipates the development of SCIL (Student-Computer Integrated Learning) environments described in the previous chapter.

> The applications of communications media to education require a general design, one that can guide the development of alternative educational forms and create a congenial institutional framework in which these forms can be applied. THE STRUCTURE OF THE SCHOOL IS IN MANY SENSES THE MEDIUM OF INSTRUCTION—it facilitates certain kinds of learning modes and inhibits others.

Therefore, Joyce continues, "in order to have a chance to create alternative educational forms, we cannot simply design applications of media to education—we have to design the institution as well." For that change to take place, Joyce suggests an approach that includes the accomplishment of three tasks:

1. "A description of educational models"
2. An awareness of computer support possibilities for the models
3. The development of alternative "institutional forms"

Describing Educational Models

An *educational model* (for teaching or learning) is defined by Joyce to be "the specification of an educational environment which is likely to bring about pupil growth." Joyce and Weil (1980) have identified numerous educational practices and grouped them into four "families" of models. Each of the models, with its definition and examples for its application, is listed below.

- **Information Processing Models**—the ways people handle stimuli from the environment, organize data, sense problems, generate concepts and solutions to problems, and employ verbal and nonverbal skills.

Examples:

Taba's inductive thinking
Suchman's inquiry training
Schwab's scientific inquiry
Bruner's concept attainment

- **Personal Models**—the processes by which individuals construct and organize their unique reality.

Examples:

Rogers' non-directive teaching
Gordon's synectitics
Hunt's conceptual systems

- **Social Interaction Models**—priority to the improvement of the individual's ability to relate to others.

Examples:

Massialas and Cox's social inquiry
National Training Lab's lab methodologies
Oliver and Shaver's jurisprudential method

- **Behavioral Models**—an emphasis on changing the visible behavior of the learner rather than the underlying psychological and the unobservable behavior.

Examples:

Stress management
Assertiveness training
Nondirective teaching

The ultimate purpose of these models is to provide a framework for giving students control over their learning environments. That will not occur if the primary model is that which dominates education today: the teacher as disseminator of information learned by the student.

Computers can play a significant role in each of these models. However, the levels of computer use that have dominated educational applications in the past—response insensitive and response sensitive—must be expanded to include higher levels of CAI (idiographic and student model). The realm of computer uses for student learning must go beyond the student-as-receiver model. It must expand to include SCIL environments.

The challenge for educational leaders is to begin to consider how computers can be used in each of the models for learning listed above.

Computer Support for the Models

Our second task is to describe the possible types of support that computers can lend to the models. In this case we are concerned about computers, though the principles Joyce advocates pertain to all media. The use of computers (and other media) generally takes two forms:

1. **As a prearranged environment** that leads (the learner) through learning tasks.
2. **As part of the environment** in which students select applications depending upon the tasks at hand.

The first form, the use of computers in a prearranged environment, is what I label "student as receiver." This has been the dominant setting in which students have used computers in the traditional curriculum areas. Discussed in Chapter 2, this form generally is called "computer-assisted instruction." The use of computers is predetermined by teachers, usually for drill and practice.

The second form, which calls for using computers as *part of the environment*, coincides with the intent of SCIL (Student-Computer Integrated Learning). In SCIL settings, students are designers, practitioners, as well as receivers.

In a SCIL environment computers can provide *functional support* to the Joyce-Weil models of learning in four ways. The computer (1) presents the learning tasks, (2) allows alternative approaches to the learning tasks, (3) provides feedback, and (4) stores information. In each type of support, students either are provided or provide themselves with the tools to manipulate information and perform the tasks in conjunction with present learning goals.

Presenting the Learning Tasks

Students and teachers use programs that contain learning packages. Students are in the role of receiver in terms of the dissemination of information to be learned. This is the dominant approach to use of computers in education today. School districts purchase software that is directly related to their curriculum. Vocabulary development, math and history drill and practice, and SAT preparation are examples of software in this category.

Allowing Alternative Approaches

Students and teachers will develop and/or apply programs in a variety of ways. In some cases drill-and-practice or tutorial programs will be an appropriate starting point for students. From there, assuming adequate completion of the first step, students use computers in the role of designer or practitioner, depending upon the task.

Providing Feedback

Computers can provide feedback in several ways. First, students as receivers can use CAI feedback mechanisms in programs to determine their progress A second way students are provided feedback is during the process of designing programs: Students are provided feedback when they attempt to "RUN" their work on a computer. Error messages or a smooth run will occur. In the case of a completed run, students must always know whether the completion produced the desired results, not merely that the program got all the way to its end without errors.

As practitioners, students must be trained to analyze the results of their work. Students must question the sources of their information. They should become aware of the programmed processes that manipulate data, as well as know how statistical packages work and know the models from which simulations are based.

Storing Information

Many types of information are stored using computers. Programs are stored on disks or tapes, allowing students to resume their work at a subsequent time. The results of student work with CAI materials can be stored if the materials are programmed to that type of record-keeping. In using word processors, simulations, data bases, and spreadsheets, students have the option to save their work.

Once educators understand the educational models and the support possibilities that computers provide, they have the foundation for attacking the third task: developing alternative institutional forms. The development of alternative institutional forms is necessary if the goal is to create SCIL environments.

Alternative Institutional Forms

Few educators have expressed concern or interest in the impact of computers on institutional change. Licklider and others have developed scenarios that depict the demise of centralized, institutional learning environments. Most school officials have met the pressure to bring computers into the schools by purchasing computers and introducing programming and "computer literacy" courses. Yet there has been minimal integration of computers into standard curricula areas, except for drill and practice.

Joyce calls for organizing schools around "specific educational functions rather than around classrooms and teachers." Some schools have been organized around departments, allowing departments to centralize resources for teachers and students, to create aesthetically appropriate settings, to share ideas among staff. Other schools have been organized around the academic needs of students. These schools focus primarily on creating environments that permit students to receive academic support or to move more rapidly in their academic pursuits. Examples of environments include media centers, tutorial centers and laboratories for experiments that go beyond traditional curricula. The major questions in education would become "which learning models to use and in what combinations," and how computers (media) will be used to support the learning models. Preliminary attempts to answer those questions have been offered in the first part of this chapter. Where do we begin if we want to reorganize schools in ways that are consistent with SCIL environments and with efforts at personalizing an individual's educational experiences?

Most change efforts begin with a district or school-based needs assessment. Bill Fisher, director of WICAT Education Division, in a recent interview, suggested that school administrators ask the following questions as they move toward fusing a SCIL-based environment (and other technologies) with a traditional school environment:

- What are effective learning systems?
- What is the best mix of traditional instruction and technology?
- In terms of implementation, how does technology change the roles of principals, teachers, and students?
- How does information we have about students affect the processes of instruction?

The questions are consistent with the emphasis I have placed on defining computer uses in schools not in terms of computers teaching, but in terms of students learning.

The starting point for exploring the use of computers to individualize instruction, according to Fisher, is to examine effective learning systems and the relationship of technology to those learning systems. WICAT has been advocating the "learning lab" approach, with computers in the lab. A brief description of WICAT's approach was included in Chapter 2.

The learning system evidently advocated by WICAT places the student primarily in the role of receiver. Students are brought into the lab and work on particular curriculum areas. Because the WICAT curricula are standardized, they are not always consistent with state and/or locally mandated curricula requirements. Therefore, teachers use the WICAT materials for a variety of purposes: tutorials, supplementary work, drill and practice, and enrichment. Students might spend from 10 to 25 minutes a day using the CAI materials. Teachers work with students in class environments prior to using the WICAT materials.

Included with the WICAT materials are computer-based record-keeping programs that allow teachers to evaluate the progress of their students. The progress reports are used by teachers to prepare regular classroom activities that are in consort with each student's advancement and the CAI materials. From Fisher's perspective, WICAT effectively answers the first two questions.

In developing a rationale for SCIL-based environments, I have attempted to provide a framework for a broader perspective about the possible uses of computers. The families of teaching/learning models developed by Joyce and Weil, in my opinion, provide an appropriate starting point. The models are a synthesis of instructional/learning practices and ideas about how best to enhance learning by students. This starting point, therefore, provides the framework to identify the learning environments and the roles of computers needed to meet curricula objectives.

In my opinion, ***individual classrooms with individual teachers cannot possibly provide a variety of learning environments, including SCIL environments and individualized education, in an effective way.*** Teachers have too many tasks and roles to fulfill. A list of responsibilities of classroom teachers bears this out. In terms of their students, individual classroom teachers today are responsible for:

- Skills training
- Educational paths
- Social environment
- Peer relationships
- Supervision
- Control
- Decision making
- Authority
- Organization design

In essence, educators are human resource managers. With these responsibilities, educators have to think through the kind of classrooms, schools, learning environments, and conditions that reflect explicit policies to fulfill their responsibilities.

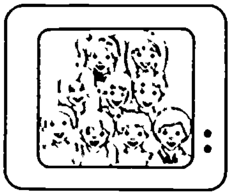
In summary, educators must begin with a concept of effective learning environments. The environments develop, in my opinion, according to the following steps:

Step 1: Train in the "models of learning" as perceived by Joyce and Weil.

Step 2: Develop SCIL opportunities in the context of the models of learning.

The primary resources needed for these steps include ***time*** for training, and ***money*** set aside for training efforts.

The next chapter (Chapter 5) discusses Fisher's third question about the changing roles of principals, teachers, and students. Chapter 6 examines Fisher's last question—How does information we have about students affect the processes of instruction? —in the context of computer-managed instruction.



Chapter 5

TRAINING: AN OLD STORY WITH A NEW ENDING

> If we attempt to "graft" the computer onto the present institutions without major changes in teaching methods, teacher training and expectations, and administrative structure, then the power of these machines to help will be dissipated.

Smith (1982), above, in part of what is a cogent summary of the issues surrounding the use of computers and individualized instruction, simultaneously sounds a warning and sets an agenda for change. *Any innovation is disruptive,* regardless of the intent of the change agent, because the innovation is an intrusion that affects well-established teaching methods, social relationships, and administrative organization.

To overcome the rather rigid, structured form of educational institutions, efforts to change must be systematic. In previous chapters I have developed a rationale for the use of computers in education. In the foreground the focus is on students rather than computers, with the setting being Student-Computer Integrated Learning (SCIL) environments. I have also suggested the use of "learning models" as a foundation for developing alternative learning environments. Now we must examine the third question that Fisher raised (see previous chapter): "In terms of implementation, how does technology change the roles of teachers, principals and students?"

(Re)Training Issues

The first step in the change process is training or, perhaps better put, the "retraining of educators." The term *retraining* is used because it connotes a more thorough, indepth, and systematic approach to staff development and inservice education than what has occurred in the past. The usual efforts by districts to encourage or force change on their teachers, or to offer inservice experiences, simply have not worked. Such efforts do not work because *transfer* of the knowledge and skills to classrooms most often does not occur.

Training for administrators is also an important step in the change process, according to Frank DiGiammarino, leader of the Lexington (Massachusetts) school district's efforts to use computers. Administrators must have a thorough knowledge of the implications for planning if they want to use computers effectively. Too many administrators, in DiGiammarino's opinion, are defaulting their position of leadership to computer specialists. In many cases computer specialists are dictating the form and content of administrative and educational uses of computers, particularly in those districts with mainframe and minicomputer systems.

"The usual efforts by districts to encourage or force change on their teachers, or to offer inservice experiences, simply have not worked ... because transfer of the knowledge and skills to classrooms most often does not occur."

Administrations must be willing to undergo training in the administrative and educational uses of computers. Fisher (WICAT) advises administrators to overcome what he calls the "mystery-mastery complex." He suggests a "vertical digging" approach, whereby each administrator learns one facet of computer applications in education, and that will lead to further questions and broader understanding.

Administrators also should experience the same training as teachers. The Garland (Texas) School District recently began using WICAT systems in their elementary and middle schools. Lyn Riggs of the Garland School District said that the training sessions were more extensive for principals than for teachers because the principals had responsibilities as instructional leaders. Principals experienced two weeks of training; teachers, one week.

Joyce and Showers have recognized the importance of training administrators by including strands for administrators in their training institutes held at the University of Oregon. The training methodology is based on Showers's research on the use of "coaching" in inservice training. One purpose for including administrators in the training is to increase their awareness of the processes of change classroom educators experience. Administrators, as they become more knowledgeable of the goals and methodologies employed by teachers, can act as coaches as well as facilitators of change. A second purpose is to make administrators aware of the variety of environments in which learning occurs and their role in providing those environments.

Administrators, as well as classroom teachers, must also become familiar with the large number of SCIL-based environments that allow computers to be used for purposes of instruction and learning. The environments include:

- A room with "stand-alone" or networked computers for each student.
- A classroom with a single computer.
- A classroom with several computers.
- A classroom with a large monitor used for teaching purposes.
- A school with computer centers, including student libraries, department resource areas, and classrooms.

Each of the environments (additional ones could be listed) suggests different types of learning experiences on the part of students, and different management issues for teachers and administrators.

A traditional classroom with a computer for each student has several uses. Students in a non-networked computer environment can use computers to work on individual projects or software as selected by teachers. In an environment of networked computers, teachers usually control the lessons from a master computer. Students usually work on the same lesson, with the teacher able to monitor the progress of each student. This latter approach, in my opinion, reinforces the teacher-dominated approach to education, and does not fully take advantage of the power of computers.

Teachers with a single computer or several computers in their classroom must be more selective of their use. They might have students who are poor writers use a word processor. Students who have been absent might use drill-and-practice software to "catch up." In addition students could create crossword puzzles for current units of study, using software like "Crossword Magic."

As graphics packages become easier to use, teachers should be encouraged to use them with a large monitor to convey concepts that are difficult to represent verbally or on a blackboard. Science experiments, art work, maps and animation are enhancements to traditional classroom presentations.

The last environment is the one that all schools should aim to have. Computers are available in all environments that students use. Appropriate software is available for student use. Whatever the environment in which students find themselves, students could use computers to access or develop data banks, to use word processors, subject-matter software, graphics packages, simulations, etc. The computers should have printers available for student use also.

Too often school personnel restrict use of hardware because they fear damage My personal experience has shown that the greater the access to computers, the better the students treat the computers. The real security issue is with the software.

Whatever the number of computers, and the environments in which they are used, they do force educators to examine how they operate. The issue then becomes one of h..w to provide an environment for educators to change.

The training model explained in the next section includes SCIL environments, the retraining of teachers and administrators, and a coaching component.

A Training Model

It is the implementation process that will determine the success or failure of developing SCIL environments for the purpose of individualizing education. At this point I must emphasize that when an implementation process is being discussed, I am thinking in terms of years, not weeks and months.

The first year of training will focus on assisting individual educators with their day-to-day routines. For example, they will be trained to use:

- Computer-based record-keeping systems
- Word processors
- Individual data bases, filing and report packages
- Integrated applications packages
- Graphics software

The first phase of training has three goals:

1. Educators will understand that the skills they have acquired are appropriate for their students to acquire.
2. Educators will understand that the skills they have acquired are appropriate to the subject matter that is taught and, in the case of administrators, to managing a school or district.
3. Educators will use computers on a regular basis to assist with day-to-day management and instructional routines.

The second year of training should be in the specific content areas for which teachers (and administrators who teach or manage curriculum areas) are responsible. Administrators without teaching responsibilities also should be trained to use computers in a content area. In elementary schools I suggest that the staff mutually decide who will be trained in what curriculum area. In that way, each curriculum area will be covered, and someone in each building will become a resource person for the remainder of the staff.

During this second year, educators will use in the content areas the skills they have acquired the first year. The goals of the second year of training include the following:

1. Educators will understand the uses and limitations of computers in the pursuit of knowledge within a particular field of study.
2. Educators will state and attempt to reach selected curriculum objectives by providing students with opportunities to use computers in content areas.
3. Educators will become cognizant of software and hardware requirements for using computers in content areas.
4. Educators will become cognizant of how individual students develop in their roles of designers, practitioners and receivers (see chapter 3).
5. Educators will make recommendations for software and hardware and location of hardware.

During the third year, teachers and administrators will be trained to use the learning models developed by Joyce and Weil. That training will take place in the context of subject-matter-centered SCIL activities that were used the second year and additional activities developed as a result of the training prior to the start of the third year. The focus of the training will allow educators to integrate the various learning models with SCIL activities. The goals, therefore, of the third year of training are as follows:

1. Educators will use a variety of learning models in the context of SCIL environments.
2. Educators will further develop their "coaching" skills.
3. Educators will evaluate hardware and software for possible upgrading.
4. Educators will evaluate and make recommendations for alternative learning environments.

During the second and third years of training, staff members will record how students reacted to the variety of learning activities. They will then have a database to make judgments about the relationship between the activities and the progress of individual learners. During these two years, educators will also be introduced to elements of Educator-Computer Integrated Management (ECIM) processes (see Chapter 6).

The fourth year of training will include the implementation of alternative learning environments in each school and of a systematic method for individualizing learning experiences. At this time ECIM processes will be in place. The following goals will serve as the framework for evaluating the fourth year:

1. Educators will identify alternative learning environments that recognize individual student differences and similarities.

2. Educators will evaluate the individual progress of students.
3. Educators will evaluate the training model.

The training model that will be used throughout the four years of training has been developed by Joyce and Showers. The training model itself has four components:

1. Trainer provides theory and demonstration in integrated environment (that is, student population, objectives, teaching/learning model, learning center, computer role).
2. Participants practice sample training units in the simulated/integrated environment.
3. Participants undergo feedback training.
4. Participants use computers in their own situation with "coaching" support.

The element that enhances the prospects of the transfer of skills to "real time" education environments is "coaching." Joyce and Showers define *coaching* as "helping teachers analyze the content to

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"Coaching ... helping teachers analyze the content to be taught and the approach to be taken, and making very specific plans to help students adapt to the new teaching (learning) approach."

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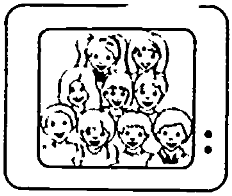
be taught and the approach to be taken, and making very specific plans to help students adapt to the new teaching (learning) approach." As coaches, teachers observe one another while they use the new learning models in the variety of learning environments. They are trained to observe, give feedback, and make adjustments from the information provided by their fellow coaches.

The addition of the coaching element to training has important implications for administrators. First of all, administrators must know and practice the training model. Consequently, they, too, must undergo training in the processes of the model so they may understand and participate in it. Second, because teachers also act as coaches, time must be allowed for teachers to be coaches. Administrators must reckon with the fact that the coaching process is inconsistent with the traditional one-teacher, one-classroom organizational pattern that dominates education. New organizational patterns are necessary to allow coaching among teachers to occur.

Administrators must also consider the implications of the concept of integrated learning environments. These environments likewise are not consistent with typical organizational patterns in schools. Computers used to assist in management, however, may be able to contribute in part to the change process.



Chapter 6

EDUCATOR-COMPUTER INTEGRATED MANAGEMENT

The impetus for computer-managed instruction (CMI) came from the early days of computer-assisted instruction. The purpose of CMI was to score diagnostic tests, develop prescriptions for study, and keep records for the purpose of generating reports. In short, CMI was to provide support for individualized education.

Use of Computers for Managing Individualized Learning

As individual students must be the starting point for using computers for learning purposes (SCIL), so individual educators must be the starting point for using computers for management purposes. Hence, the acronym *ECIM* (Educator-Computer Integrated Management).

In the context of traditional CAI (student as receiver), the availability of computers has permitted educators to develop systematic instructional approaches to individualizing instruction for the first time. In Fisher's opinion, computers have given educators the capabilities to address fundamental issues:

- How to assess an individual student
- How to track the progress of an individual student
- How to interrelate information from the first two points to instructional objectives.

There are many ways to assess the learning styles of individual learners: standardized tests, observations by educators, interviews, and records of past performances. The information from these sources can be combined in computer-based records. An ample amount of literature is available on individualized instruction (for example, "learning styles," "cognitive styles") and methods to develop profiles of students.

Computers traditionally have been used to monitor the progress of individual students via computer-assisted-instruction systems at response-sensitive and idiographic levels. The WICAT and PLATO systems include capabilities to monitor student progress and to branch to alternative learning sequences based upon student progress.

In this booklet, however, I have gone beyond the traditional concept of computer-assisted instruction, which views the student's role primarily as that of receiver. Students are able to use computers in a variety of ways. To encompass a more comprehensive view toward student use of computers, I have used the concept Student-Computer Integrated Learning (SCIL). (Of course, not all learning experiences are or will be computer-based.)

To take advantage more fully of both individual student differences and the availability of increasingly sophisticated software and more powerful hardware, I have also discussed the importance of creating alternative learning environments (SCIL environments) within schools. Creating those environments and simultaneously individualizing student learning experiences requires a sophisticated management system. Computers can assist in that effort.

SCIL Environments and ECIM

One type of ECIM (Educator-Computer Integrated Management) approach has as its basis the SCIL environments that have been described earlier. It is important to keep track of the progress of individual students. The importance of record-keeping is heightened if the setting has different types of learning centers or varied environments based upon learning models, individual student profiles, and technology. Teachers and administrators in that situation should have access to computers in which student records can be updated daily. In addition, personnel responsible for monitoring the progress of each student can develop individual schedules for students simply by generating reports stored in computers.

Computer-Based Information Banks

A second type of ECIM uses a computer-based information bank as a starting point. This information bank can be used even if a district is doing very little with Student-Computer Integrated Learning.

Three primary data files are included in such a bank. The first contains information about each student. Sources of information include:

- Achievement, aptitude, diagnostic and teacher-made tests
- Anecdotal reports
- Attitude scales
- Conferences
- Group discussions
- Interest inventories
- Needs assessments
- Questionnaires
- Sociometric devices
- Work samples (Stewart)

A second information component contains the school district's instructional objectives and the resources appropriate to achieving those objectives. Information about each of the resources includes:

- Curriculum area
- Curriculum units
- Type of resource (for example, filmstrip, game, program)
- Location
- Appropriate grade or skill levels
- Types of input/output required of students
- A match of resources and objectives
- Teacher and/or student resources

The third component is a report generator based on the information from the first two files. One type of report, used at the beginning of a unit of study, matches the information about students to the objectives and available resources. A second type of report is based on regular input from teachers (daily and/or weekly); this report is used by teachers and administrators. These reports include a profile of each student's achievement across all curriculum areas; a continual monitoring of the student's performance in relation to established curriculum objectives; a diagnosis of the student's performance levels based on previously identified expectations; and a prescription of alternative learning approaches.

While consulting, researching, and teaching about computers, I have met school district administrators who are in the process of procurring a computer for district administrative purposes. In many cases they have *not* included in their plans uses for their about-to-be purchased computer that extend into the Educator-Computer Integrated Management domain.

When buying computers, district administrators should consider the applications of those computers to the overall ***educational mission*** of their district. Administrators, if trained in the SCIL-based activities, readily would see that many of the same functions for which they anticipate using their computers are equally appropriate for teachers and students: the input of data, the storing of data, the manipulating of data, and the output of data. Therefore, to make their computers accessible to teachers and students, administrators should consider linking their central-office computers to terminals or microcomputers in the schools. Such usage would require larger storage capacities, and it would provide opportunities to take advantage of both centralized and decentralized computer-management systems. Local area networks make such linkages feasible.

Computer-based management packages to individualize education are most commonly found in the context of special education. Writing and monitoring Individual Education Plans (IEPs) for special education students require a considerable amount of effort and paper work Enell (1983) provides a comprehensive analysis of the role of computers in relation to IEPs; she also lists vendors and school districts that use computers for special education. The models used for special education are applicable to any school environment in which the emphasis is on the progress of each student.

Impact on Organizational Life

With the development of an "information environment," educators

> generally have greater access to data and, in particular, data relevant to their own decision making. The capacity for followup and reorganizing increases as information retrieval and communication can occur with greater ease and convenience than ever before (Zuboff 1982).

In Chapter 2, I noted that the original goals of CAI included increasing the effectiveness of the instructional process. Zuboff, writing in the context of her study of companies that use computers for management purposes, states:

> This speed of access, retrieval, and information processing is allegedly the key to improving the productivity of the organization, but few organizations have seriously considered the appropriate definition of productivity in their own operations.

Have we as educators defined what we mean by *productivity?* What are our goals? Are they increased test scores? Socialization? Moving toward potential? Whatever the answers may be, they will have an impact on how the schools will be organized in the future. The new information technology is going to create alternative management designs, and school administrators must begin to think about the implications of these designs.

"... there will develop a changing relationship between all educators and their jobs."

First of all, there will develop a changing relationship between all educators and their jobs. Educators must understand the impact that the information technology will have on their work. They need to be provided with the knowledge and authority to take advantage of the new resources at their command.

Second, administrators and supervisors must begin to rethink how teachers are taking advantage of the information available to them. In a school with a variety of learning environments that are based on learning models and the progress of individual students, educators will be making many more management type decisions than in traditional classroom environments. Instead of evaluating teachers primarily on their control of students in a single classroom, administrators will be observing more decentralized environments. Teachers must be trained to make those management decisions, and administrators must be trained to examine the decision-making capabilities of teachers.

Lastly, the hierarchical organizational patterns that dominate schools will more than likely shift to a pattern that is somewhat more horizontal. Teachers will have access to greater amounts of information that can assist them in their interactions with their students. The concept of working in an "organization" will change because new patterns of decision-making will occur.

"... the hierarchical organizational patterns that dominate schools will more than likely shift to a pattern that is somewhat more horizontal."

Administrators are confronted with a challenge far greater than most people have considered. Not only must they become retrained in taking advantage of SCIL activities. They must also begin to consider and possibly reconfigure their own jobs and the organizations in which they work.

CONCLUSION

Very few school districts in the United States have developed computer education policies and long-range plans that consider the use of computers in schools. These two findings, reported in *SchoolTech-News,* December 1984, were based on a survey of school superintendents.

Planning has been an underlying theme throughout this booklet. Planning in education begins with students and what we as educators offer as important learning experiences for our students. The focus of the booklet has not been computer hardware and software, what to buy and when to buy it. These decisions become a consideration *after* the goals for students are articulated and put in place. Once the goals are in place, then, as DiGiammarino and Fisher have indicated, administrators must learn about and experience the variety of settings in which computers can have a role in education. Many types of learning environments can be created to take advantage of the capabilities of computers and well-articulated learning/teaching models.

More recent advances in approaches to professional development provide a nonthreatening approach for change that allows for integration of computers into articulated learning environments. The implementation of the training program briefly explained in Chapter 5 takes a considerable amount of planning on the part of administrators. The planning involves allowing staff (including administrators) to attend an extensive three- to four-week summer program, to participate in school-year coaching arrangements, and to attend evaluation sessions.

Eventually learning experiences for students will be based upon an assessment and daily monitoring process that is enhanced by the record-keeping power of computers. Purchase of appropriate hardware/software configurations requires administrators to plan for future uses of computers, including their location, access requirements, and maintenance costs.

Tennyson and Park (1984) have listed the characteristics of computer-based adaptive (individualized) education. The characteristics, based on a review of empirical research, include:

- Initial diagnosis and prescription.
- Continual monitoring of student progress to allow for adjustments and updating of student progress.
- Control of the amount of instruction necessary to achieve objective.
- Control of the sequence of instruction based upon student response.
- Time control to pace the exposure to instructional materials.
- Information provided to learners from which they can manage and be responsible for their own learning program.

These characteristics are as applicable to non-computer-assisted instruction environments as they are to CAI environments. Each characteristic takes a considerable amount of planning on the part of teachers. If a variety of learning environments are to occur in a school setting, vehicles for school staff planning are of primary importance.

The primary feature of individualized education, or learning, is timeliness. Timeliness requires a well thought out learning management system. It requires educators—administrators and teachers—to constantly make decisions about the progress of their students. The dichotomy that presently exists between management (by teachers of classrooms, by principals of schools, and by administrators of districts) and effective learning must be overcome.

The challenge of educators is clear. That challenge is based on the goals each district has set for enhancing the learning opportunities of the children it serves. Computers are not *the* vehicle to reach those goals. They are but one of many. The issues, the challenges, and the accomplishments are still based on human skills, skills that take advantage of cumulative experience to select and manipulate tools and media that are appropriate to a given task. Do we ask any more or less of our students?

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