"Not In Print"

What Can and Cannot be Learned from a Review of Recent Literature and Research on Integrated Learning Systems

I

Executive Overview of Major Findings

II
Introduction

The vision of an INTEGRATED LEARNING SYSTEM has been central to computers in education since the field began thirty years ago. The vision is of an automatic machine that delivers individually customized knowledge to the desk of each student. The system discovers the student's current educational level and then interests and motivates that student to absorb both facts and skills needed to complete his or her educational plan. Throughout, the computer system provides reports on educational progress for teachers, school, and parents. Early on, proponents of this vision discovered that its implementation would require a process of extensive theorizing, research, development, and testing as well as changes in standard school practice. We are now somewhere in the middle of this process.

The report before you surveys the state of the art of Computer-based Integrated Learning Systems (ILSs) in the late 1980's. The Sections of the report are:

It is the result of an extensive search for written materials that describe, evaluate, and compare currently-available (1988) ILSs. The systems surveyed are mini or microcomputer-based networks of student learning stations that manage and deliver multi-subject, multi-level instructional materials in an elementary and/or secondary school setting.

Although there are several informal articles, NO PUBLISHED MAJOR STUDIES OR REPORTS FOCUSING PRIMARILY ON INTEGRATED LEARNING SYSTEMS WERE FOUND. The content of this report was, therefore, extracted from multiple sources, including: research reports and reviews covering older systems not currently available; descriptive studies of current ILS products undertaken by schools, local school districts, or state departments of education; marketing materials from current ILS vendors; telephone interviews with company marketing representatives, in-house developers, school district technology specialists, and university evaluators; popular and academic journals on educational computing, and independent consultants.

Armed with this information, the reader will be in a strong position to assess the needs of his or her particular

instructional situation and the potential of each product to satisfy that need. Further, readers will be able to specify the enhancements needed to provide a superior product for integration into the existing curriculum of today's elementary and secondary schools.

The heart of the matter can be summarized in five short findings:

1) Theory - Educators disagree about basic pedagogical principles related to learning and about the importance of mastering specific content areas. Although much research has already been done and more is in progress, we still have only partial theories concerning the fundamentals of design and implementation of ILSs. Lacking a strong theoretical base, decision makers often emphasize **positive gains in objective test scores even though research does not demonstrate that these gains result from use of the computer system.** Implementing improved teaching procedures that could be delivered by either computer or more traditional methods may explain the gains found to accompany computer based instruction.

2) Research - Rigorous empirical research comparing appropriate variables within controlled studies is rare. Current research is largely descriptive. It reports, usually incompletely, how ILSs actually function in the field. **In most cases, computer-based intervention is better than no intervention.** The real question is, however, **which computer-based treatments are most effective under what circumstances?** This question is just beginning to be addressed.

3) Development - The state of development of ILSs is piecemeal compared to the on-going vision. Each system is underdeveloped in one or more components, including: delivery, diagnosis, testing, individualization, content presentation, remediation or reporting. Major questions are still being debated concerning, for example, the **usefulness of complex reports** for teachers or the **reliability of diagnostic, placement and achievement testing**. Such fundamental factors as reliable hardware and software functioning, and vendor support still play a major role in the value of an ILS to all stakeholders.

4) Evaluation - The cost, in both dollars and disruption, required to thoroughly test whether an ILS product will do the job for a school is prohibitive. Therefore, **implementation decisions are often made and defended in an atmosphere of political hope and compromise** rather than one of scientific inquiry.

5) School practice - Today's schooling is built around the **teacher-centered classroom**. This promotes the enculturation

of young or inexperienced human beings (students) by older or more experienced human beings (teachers). Introducing an ILS modifies this relationship on many levels and is met with a mixed welcome. Although most ILSs provide for considerable **teacher control of curriculum**, too many teachers fail to exercise this option.

III

THE LEVEL OF DEVELOPMENT OF ILSs COMMERCIALLY AVAILABLE TODAY

At the present time, no two ILSs appear to be designed to do exactly the same job for exactly the same population of students. Each has specific areas of strength and weakness which determine how well it will perform in the unique environment of a particular school. However, all ILS companies are investing heavily in new product development making them constantly moving targets for evaluators. There is considerable cross-fertilization occurring as companies make and break joint development and marketing agreements and as seasoned personnel change employers or set out on their own to form new companies. **Information being read today is three to six months old at best and will not accurately reflect the market six months hence.**

Some dimensions for comparison

Age, Achievement, Breadth, Purpose, Strategy, Flexibility

Most integrated learning systems emphasize basic skills remediation in English and arithmetic. However, some are targeted for initial skills development at kindergarten through second grade levels while others provide remedial exercises for high school and adult learners. Still others cover one or two subjects quite completely for all AGEs. A second dimension is ACHIEVEMENT level within age or grade group. For example, a fifth grade math program can stretch all the way from drill in addition to introduction of pre-calculus concepts. BREADTH of subject matter offered also distinguishes different products. Several systems offer only basic math and reading at the present time while others are also strong in sciences, social studies, and/or foreign language. The dimension of PURPOSE separates software that provides initial presentation of new material from that designed to review and drill after an introductory learning experience in the traditional classroom. Although the notion that a computer might substitute for a teacher is no longer in favor at this time, more than one developer noted that some inner city teachers were improving their practice by observing the instructional strategies used in the computer lab. These basic pedagogical STRATEGIES also differ widely. One end of the spectrum might be described as "tell 'em 'n drill 'em." The opposite end provides tools such as word processors and

calculators and instruction in "making inferences" or other components of problem solving. FLEXIBILITY also varies tremendously across different ILS products. Some permit buyers to mix and match from a large catalog of software while others offer a relatively fixed product.

Only two categories for older systems

Proprietary and school selected

The dimensions of age, achievement, breadth, purpose, strategy, and flexibility describe the pedagogical character of the software available in an ILS. In the past, ILSs were divided into two additional major categories: proprietary courseware (for example, Computer Curriculum Corporation, PLATO, Dolphin or WICAT) and school selected courseware (for example, Computer Networking Specialists).

Each proprietary software package was available from only one ILS vendor and embodied a unified pedagogical strategy across subjects and grade levels. Often it ran only on hardware supplied exclusively by the same vendor. Proprietary systems were usually more expensive and less flexible but offered more sophisticated pedagogy with supporting research results.

School selected courseware systems incorporated educational software from a variety of publishers and permitted/required the purchaser to structure the scope and sequence of the curriculum delivered by the ILS. The ILS vendor had selected and modified each program to interact with the diagnostic and reporting programs it supplied. Typically, school selected courseware vendors offered complete hardware/software/training packages or would work with schools to reconfigure existing stand-alone machines into their networks. These systems could cost less especially for districts that had pre-existing hardware and/or hardware maintenance. They incorporated the variety of pedagogical approaches used by individual software developers and publishers. Therefore, they might appear inconsistent to both teachers and students. They required someone from the school, classroom teacher, curriculum specialist, or administrator, to attend to the selection of computer-based curriculum in order to coordinate with teacher-provided curriculum. Although research indicates that students exposed to such systems show some test score improvement compared to students without computer assistance, there is no data on whether the same software results in higher gains when used in an ILS rather than on separate microcomputers.

In today's market place, these categories have become blurred. For example, Control Data's PLATO system, which used to be purely proprietary, has metamorphosed into the LPDS (local PLATO delivery system). Workstations may be either Apples or MS-DOS compatibles in a local area network with the LPDS central

computer and hard disk. Much of the software in this system has also been available in stand-alone versions for several years. By contrast, Educational Systems Corporation (ESC) and Wasatch, newcomers to the market compared to Control Data, are moving in the opposite directions -- from multi-publisher software into proprietary courseware.

Local implementation dimensions

Time, Space, Staffing, Acceptance, Planning

Several additional dimensions to be considered relate to the logistics of implementing an ILS in a particular school. These include: student contact time with courseware, space constraints, adequate staffing, teacher acceptance, and future planning.

Among the most important contributors to student benefit from any ILS is the right amount of time spent actually working on the lessons. This relationship is subtle and cannot simply be seen as "more time on task is better." If a student does not have sufficient time to complete whatever instructional module the management program uses to advance the student, he or she will not be correctly placed in the sequence of drill or instruction even after the concepts have been mastered. This can result in the disastrous situation of a student repeating part of the same lesson at the computer day after day. Factors such as student travel time to the computer, time to load the program, and time for the student diagnostic/prescriptive program to run can combine to make it difficult to know how to schedule students appropriately.

IV

THE TYPE OF RESEARCH AND EVALUATION UNDERTAKEN SO FAR

School districts do not rely on printed research and evaluation materials except those supplied by vendors when making their choice of whether to buy an ILS or which ILS to buy. Most of the information they seek is simply not in print. What is in print and how is it useful?

Popular educational computing press

Several recent articles, by Lehrer, Marshall, Reid and others, Reinhold, and Smith, give cogent overviews of some of the ILS products now on the market and list important questions to ask during comparative evaluation. (See Appendix A, articles listed alphabetically by first author.) Collectively, these provide a good introduction to the field.

School district publications

Also likely to be useful are the Guides and Manuals produced by single large school districts to help their own schools select among ILSs approved by the district for purchase. Only the booklet from Portland, OR was received in time for inclusion in Appendix A. However, others were mentioned during telephone interviews with districts and may possibly be obtained by contacting the school districts included in Appendix D.

School district evaluation studies

Several large school districts, particularly those with many students qualifying for federal Chapter I funding, have evaluated the older ILS systems, including CCC, Dolphin (not currently marketed), PLATO, Prescription Learning (PLC), and WICAT. A few of these evaluations are available through the ERIC document service. (See Resta, Licthenheld, Hawaii, Chamberlain, in Appendix A.). These papers report problems of implementing a new system and how to do evaluations but, by the time they are published, the products they cover are obsolete.

Vendor supplied outcome studies

Studies of improved student performance are available from individual vendors. CCC, CNS, ESC, and WICAT all provide pre and post-test data indicating improved scores on nationally normed tests after student exposure to their systems. These reports do not, however, mention unpublished negative data nor do they compare competing ILSs.

University based literature reviews

Three major literature reviews, by Becker, Kulik & Kulik, and Roblyer and others, summarize the academically oriented research on the educational effect of computer based learning. All find that computers in classrooms are accompanied by many small to moderate gains, a few outstanding gains and some losses. This leads Cleborne Maddux to comment, in the Preface to Roblyer's book, "we need no more research intended to test computer vs. non-computer teaching. Future research should instead be aimed at finding the most effective ways of using computers at given grade levels, with given kinds of students, or in given subjects," (p.8). Since all of these reviews distinguish between microcomputer and mainframe applications but none differentiate between stand-alone and micro-based ILS implementations, it is easy to agree with Maddux. Existing academic research is literally no help at all in choosing among ILSs or between the ILS and the stand-alone computer approach.

University research on ILS components

Comparative studies of ILSs as a whole are not represented in recent doctoral dissertations or in literature published by professors and graduate students. However, components that contribute to ILS implementation and design are under heavy scrutiny. Olsen, for example, has found that the results computer-administered tests correlate highly with standard paper and pencil adminstration. ..... showed that the form of the computer generated prescriptive reports strongly affected whether teachers followed the prescriptions in designing individualized programs for their students. Christensen and Tennyson are investigating how artificial intelligence methods can be used to improve diagnostic and prescriptive programs. While these piecemeal results do not attest to the overall effectiveness of any given ILS product, they do suggest whether the component strategies have been well thought out and evaluated individually.

Government studies

Although there has been much debate about what role the federal and state governments should play in educational technology, only a few agencies have published material that mentions ILSs. A 1988 report from the U.S. Office of Technology Assessment notes that.....

State Departments of Education are also studying the field and providing guidelines for their school districts. The Arkansas Department of Education's Project IMPACT, for example, has a demonstration laboratory and puts out a series of publications to help local decision makers choose

Proprietary comparative studies

Within any industry, knowledge of what the competition is doing and how they are faring is a valuable commodity. Therefore, it should come as no surprise that several commercial stakeholders have commissioned comparative studies of the make up of and consumer attitudes toward the major ILSs. Mostly prepared by independent consultants, these studies are now being sold and resold to computer vendors with an interest in the future of the ILS market. Unfortunately they are not yet available to those with the most to lose by a bad decision -- the schools.

V

THE RESULTS OF AVAILABLE RESEARCH AND EVALUATION

Given the present state of research and evaluation on ILSs, "results" must be accepted in the form of questions rather than answers. We are well informed if we know what to look out for rather than knowing what has proven best or most effective. Therefore, this section contains ten questions to ask about ILSs themselves and ten more to ask about any written materials that claim to tell you about ILSs.

Major Questions to ask about ILSs

1) How will your ILS integrate with your existing curriculum and schedule?

2) Who controls the assignments of students on-line in terms of
   a) sequences of educational objectives?
   b) inclusion or exclusion of specific objectives?

3) What are the realities of student access to the system?
   a) What are optimal student-contact times per day, week, semester, year?
   b) How much real student-contact time is practical when classroom disruption, travel between rooms, and program loading time are considered.
   c) Should students have single or multi-subject sessions?

4) What kind of reports are generated?
   a) Do they solve existing problems for
      1. teachers?
      2. administrators?
      3. parents?

5) How does cost and educational effectiveness measure up?
   a) Do teachers play a prominent role in deciding when and to what their students are exposed?
   b) Dp you have the right number of students for optimal operation of the system?
   c) Do ILS and district educational objectives match?

6) Can you achieve significant savings by incorporating existing hardware and/or software into the network?

7) How are you going to secure teacher buy -in to the ILS?

8) What provisions are there for staff development?
   a) What will the vendor provide?
   b) How will state and local offices help?

9) Can the system be maintained?
   a) for how long?
   b) at what cost?
   c) by whom?

10) Can the system be upgraded and/or expanded?

Major Questions to ask about Studies of ILSs

1) Is the study comparative or descriptive?

2) How were outcome measures taken?

3) How were students chosen for the study?

4) To whom are the computer students compared?

5) Is more than one computer treatment considered?

6) Are other factors such as teacher, time on task, previous growth within treatment population, or other interventions being use simultaneously, taken into consideration?

7) Is cost-effectiveness reported? During start-up phase? For projected life of system?

VI

THE GAP BETWEEN CURRENT DEVELOPMENT AND THE VISION

How does the current state of the Integrated Learning System art measure up the vision educators have held over the years? The answer may depend on the readers personal measure of optimism or pessimism.

Clearly, current "integrated learning systems" are not "integrated" in the fullest sense of the term. Many are "targeted" to specific subject matter, especially "basic skills" in reading and math. Therefore, they are successfully implemented in Chapter 1 or other compensatory programs where they demonstrate measurable gains in student achievement and cost effective curriculum delivery. Often, Chapter 1 labs are not available to the "normal" or gifted students and we know little about how they might be used effectively in the regular curriculum.

The more flexible ILSs and those with broader subject matter offerings do not cover standard curricula adequately. It is difficult for teachers to weave them into everyday classroom practice unless the teacher rebuilds the curriculum around them.

As one independent consultant noted: "The reason these things work or don't work has very little to do with what's in the computer and more to do with how the system is integrated into the school."

The management components of many ILSs generate excessively complex reports and require the teacher to have detailed knowledge about the system. Gradually, some teachers are learning to take advantage of the labor saving possibilities of some ILSs' management components. However, many faculty members use computer tracking to avoid attending to individual student needs. Districts report more effectiveness when teachers accompany their students in the lab and when the lab manager is a teaching professional rather than an aide.

A school district data processing manager who was responsible for installing an ILS in 1983 expressed great satisfaction with the system. He commented on the stages of integration into the curriculum that had taken place over the years. During the first year, teachers were only required to accompany their students in the lab where a lab manager handled all hardware, software and student assignment. There was no alignment between lab and classroom. Gradually, the teachers discovered that they could use the computer to reinforce classroom lessons. Five years later the teachers are still not actively selecting software although the ILS offers products from a wide variety of publishers. This administrator's expectations fall far short of "the vision." "We didn't find one teacher who was making use of the management information system," remarked an independent consultant who visited five schools, each using a different ILS.

How about the educational strategies which guide the overall structure of each ILS? Most people who had evaluated CCC and/or WICAT agree that these systems offered the most sophisticated pedagogical approaches. However, the cost of proprietary, leased hardware and the relative inflexibility of the software tip the scales in favor of MS-DOS or Apple networks for many districts.

For the time being, the grand vision of early proponents of integrated computer-based learning has given way to the realism of school administrators who must solve pressing educational problems, one at a time. Instead of a marvelous teaching machine at the core of the modern school's instructional program, we see today's ILS used only in a tentative and supplementary manner with mixed success. Today's systems can be both cost-effective for schools and educationally beneficial for students when careful planning and implementation matches school and system along all the dimensions of the task the ILS is to perform. However, the gap between current development and the vision remains a large one with much of the theory, research, and development still ahead of us.

Appendix A:

Sources and Suggested Reading

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Appendix B

Brief Descriptions of Today's ILSs

CCC

This proprietary hardware/software system received high marks for its instructional design but was generally viewed as too expensive and not sufficiently flexible to meet the needs of many school districts. Some evaluators reported problems with the graphics interface to the Atari ST computers which serve as terminals. Others felt the reporting system was too complex. A few did not find the curriculum sufficiently comprehensive. Overall, the company is well respected as a long and strong force in the market and is expected to remain so if it can meet the price competition.
sources: company, various evaluating school districts.

CNS ClassWorks

Very little criticism of this system is to be found. Districts that have installed it are enthusiastic about the level of support provided by the company and the flexibility of the software. The present sofware is comprised of ClassWorks, the CNS developed management system, keyed to software from over thirty publishers. Each program has been modified so that delivery of the content and evaluation of student responses is under the control of ClassWorks. CNS runs on various Apple networks with hard disk. Also, company representatives revealed that they expect to have an MS-DOS product on the market soon. A carefully designed evaluation study of this product, covering four elementary schools, one middle and one high school, is underway in Moorehead, MN. Results should be available in 1989.
sources: company, various evaluating and using school districts; Dr. Austin Mathis, Glendale, AZ; Randy Skupian, Bolixi, MS.; Dr. Joe DeCola, Moorehead, MN.

CSR

This MS-DOS based diagnostic-prescriptive program is not comprehensive enough to be classed with most of the others reported here. One user described it as "SAT-like paper and pencil testing on a screen," which performed very well in her after-school learning center. An instructional computing specialist described it as "real primative." Although its 250 modules are easy to use and permit flexible choices, many of them were not seen as appropriate to the computer medium and there are no tutorials. CSR's sales department was not available by telephone so little direct information was obtained.
contacts: evaluating school districts; using learning center; Dr. Barbara Kurshan, Roanoke, VA

ESC

This compact disc-based software available for both Apple and MS-DOS networks has been very satisfactory when used appropriately. Its self-contained language arts and math software is less flexible than its competitors and requires that each student receive from 20 to 45 minutes of contact at least 3 days per week to complete modules. Shorter sessions result in excessive repetition of uncompleted lessons. In its favor are excellent instructional design, use of mouse, audio, and microphone as well as cost. Respondants reported that the hardware running under IBM's ICLASS was more reliable than the Apple network version.

Dolphin

Although currently out of the market, company representatives suggested that this Houghtin-Mifflin division would be in the running in the future. No details available now. The existing time-share installations are being supported and arrangements for users to buy out their leases are underway. Some software is available in stand-alone format.

IBM ICLASS

IBM's strategy was described as selling to top management, leaving the rank and file out of the decision-making process. Although this tends to creat some dissatisfaction among district and local personnel, no criticism were made of the hardware and software itself. ICLASS employs a variety of formerly stand-alone software from IBM, WICAT and other third party developers. The entire ESC system is available under ICLASS.

Ideal ICLS

According to company president, Gary Volding, this combination of in-house and third-party software offers individualized management running on various Apple network/hard disk systems. A Macintosh version is under development. The math package covers grades 1 through calculus, the writing package is comprehensive, and there are also modules for upper elementary science, physics, biology, and chemistry.

MECC MMM

No respondents classed the MMM system with the more fully developed Integrated Learning Systems. It was perceived as a menu system to provide easier access to a selection of stand-alone software rather than a management/instructional system.

PLATO LPDS (Local Plato Delivery System)

Contacting a PLATO representative was, in itself, a difficult task and little information about this latest offering was obtained. The original mainframe PLATO is now marketed exclusively to higher education. The LPDS is targeted for high schools although its basic skills in reading and math can be used with lower grades. The network can be set up for either MS-DOS

or Apple work stations and features GED software as well as algebra, geometry, calculus, social studies, physics, and chemistry.

PLC

Prescription Learning Company claims to have the largest ILS market share with an installed base of 3,000 systems. It features k-adult curriculum in language arts, reading, math and writing mostly developed in-house. Their computer network can download to a mixed collection of MS-DOS and Apple computers and schools may design custom labs with a variety of audio and video media.

Wasatch

This relative new-commer stresses a wholistic approach to pedagogy, emphasizing basic thinking skills and avioding drill and practice. A company representative said it is being used successfully in Chapter 1 labs in Chicago, Cincinatti, and Cleveland. Schools in Portland, OR, however, prefer it for mainstream middle school algebra, science and literature. It's unique features include easy access to application tools such as word processing and spread sheets while under a management system and extensive use of off-line classroom materials. It runs on MS-DOS networked micros with hard disk.

WICAT

This proprietary hardware/software system is considered excellent by some and overrated by others. A pioneer in the use of sound and video disk, WICAT labs focus on teaching, not remedial practice. With extensive elementary reading, math, and language arts software, students in WICAT's experimental school may spend as much as three hours per week on-line.

Appendix C

Individuals contacted by telepone.