Beyond Computer Literacy

To succeed in the information society, students need more than the ability to program an Apple; they need information management skills.

JAMES QUINN,
JOSEPH KIRKMAN,
AND CORA JO SCHULTZ

On the morning after release of the devastating report of the President's National Commission on Excellence in Education, a Los Angeles school administrator announced that his district's ambitious and enlightened intention to add computer literacy to the core curriculum—if, that is, enough money could be found to buy the hardware and hire the teachers.

Unfortunately, computer literacy is already a ghost of education past. Students and adults of the information society need knowledge, skills, and attitudes far more generic and pervasive than simply those required to operate a computer terminal or use a basic computer language to program a microcomputer. Most important, they need to focus on the concepts and skills of information management rather than on a body of content reflecting today's microcomputers.

To guide those interested in futures curriculum development, we will (a) describe a five-year, multi-phased strategic planning process currently used by an 11-member Network of California and Canadian school districts; and (b) examine the major development issues and problems that have surfaced through the Network's completion of the second phase, curriculum development.

Phase I: The Network Forms

We used simple survey methods to identify the 11 participating school districts in California and Edmonton, Canada, and link them under the coordinating guidance of a professional service organization. The original charge shared by these districts was to develop and implement a Futures Curriculum that would help students develop the competencies needed to cope with, predict, and form their future. Both the planning process and the first products developed should be at least partially adaptable to other K-12 educators who are ready to prepare students for life in an information society.

During the initial planning and discussion sessions in late 1981, the 11-member Network agreed to move jointly toward four major outcomes:

1. The comprehensive definition of a competency-based K–12 Futures Curriculum; that is, the areas to be addressed and the skills, knowledge, and attitudes students should demonstrate as a result of instruction. More specifically, the:

a. *key content categories* of the discipline

b. *goals* or relatively broad statements of the intended outcomes of instruction

c. *competencies* or relatively specific statements of the skills, knowledge, and attitudes students should demonstrate as a function of instruction

d. *performance indicators* or highly specific task or behavioral representations of the competency domain for a specified instructional level—primary, middle, or high school

2. Development of instructional methodologies, materials, and procedures that teachers might use to help students demonstrate satisfactory proficiency in the future areas.

3. Construction of competency tests and "alternative assessments" of the competency domains and the accompanying record-keeping systems.

4. Implementation of the Futures Curriculum definitions at the district and school levels.

Districtwide, the intended outcome for each Network member is a comprehensive, fully-integrated curriculum, instruction, and assessment system of futures education that is operational and accessible by the Network districts.

Most important to the effort, and to those who would use the Network's efforts as a model, is the on-going process of curriculum definition and redefinition. Those breathing a sigh of relief over the "completion" of their computer literacy program have failed to understand this need for developing a dynamic system.

Phase 2: Curriculum Development

Phase 2, *curriculum development*, has now resulted in the selection of six futures curricular disciplines, with four having priority: Information Technology; Strategic Reasoning; Artificial Intelligence: Robotics; and Change. The two remaining areas to be developed are Life Planning Skills and Human Relations, the last considered a correlate of the country's increasingly pervasive transformation to a service economy. The completion of Phase 2, which will define the post-institutional competencies students should be able to demonstrate, includes two substantive aspects that will be addressed in the remainder of this article:

First—An appropriate definition of information technology that describes the art and skill of developing and managing the information resources supply;

Second—An appropriate definition of reasoning that describes the intuitive, inductive higher-order thinking skills as well as the deductive.

Defining Information Technology

The Network's definition of *information technology* actually encompasses a set of information management technologies that are evolving and highly dynamic. That is, the content of each technology will be continually and dramatically emerging, both independent of and integrated with other technologies. Thus the Network's definition of *information technology* identifies several interrelated technologies, and emphasizes the conceptual foundations and cornerstones of each. In this way new and certain developments will be readily assimilated into the existing framework. The students of tomorrow should be expected to understand each of the technologies conceptually, appreciate their interrelations, know their applications, and, eventually, be able to use each effectively.

• A *General Purpose Design*. Holding the center of the information tech-

James Quinn is Evaluation Systems Designer; Joseph Kirkman is Information Systems Designer; and Cora Jo Schultz is Director of Curriculum and Testing, Curriculum Systems Design, all with Peopleware Systems International, Laguna Beach, California.

nology definition is the foundation concept of a *general purpose design* of information systems. Such a design is capable not only of facilitating numerous current applications in today's computerized information systems, but also of assimilating numerous other applications not presently identified or definable. General purpose designs may be referred to as "incomplete designs." Such designs are "completed" again and again ad infinitum by programming and hardware developments that may emerge in the indefinite future. To be literate about computer technology today is to understand the advantages of the general purpose design feature of information technologies.

Beyond the foundation concept, the network's definition specifies competencies that students should be expected to demonstrate in relation to a number of information management technologies. These technologies are:

- *Encoding-decoding, or the method of representing the information supply.* Information can now be represented in forms far more versatile than the printed word. Tomorrow's information workers will be required to comprehend, at least conceptually, that each character in our language systems can be converted to a code of electronic, radio, or light impulses, which can be stored, processed, and transported (through wire, air, or glass). They will also need to understand that these codes can at any point be interpreted to their original or other language equivalent, scrambled for security and privacy reasons (requiring a special device for interpretation), and correlated to other coding schemes thereby allowing efficient exchanges of information between otherwise incompatible information systems.
- *Recording-entering, or the translation of information into various codes.* The printing press was a major evolutionary recording development of long ago. Tomorrow's advances will be the voice-entry recording of information and the use of optical readers for the purpose of entering information into the information system (converting familiar language characters and symbols to their electronic or other equivalent).
- *Storage, or the capacity for information retention.* Books and tapes will increasingly yield authority to today's most advanced storage technology, the super high-density, nonvolatile magnetic disk. Competent students should be expected to comprehend the evolution of information storage technology.
- *Processing, or the deliberate, systematic manipulation of information for given purposes.* Historically, information processing has been accomplished by individual mental capacity and data-processing machines requiring programming by technical specialists.

The post-industrial "futures leap" is the rapid development of fourth and fifth generation languages. These are the forgiving or user-friendly techniques for dynamic design completion (previously called programming) that will allow broad use of information technologies by all. Thus K–12 students who come to understand the information technology of design completion will not necessarily set sails for careers as computer programmers, notwithstanding the statistics signaling the growth of this rarified industry throughout the 1980s.

- *Retrieval-display, or the presentation or display of information in its original or changed form.* In this sub-technology of information systems, print and video advances have now been supplanted by various computer conversions, as from a stored data base to graphics, or voice output requiring logical deduction from the data base.
- *Sharing/dissemination, or the ability to move information from its origination point to the point needed.* Increasingly called telecommunications, this sub-technology will revolutionize the methods for sharing and disseminating information. Rather than physical representation and transport, information (once encoded through entry into the information system) will be entered into the communications network as a by-product of people activities, and will then be available for use by others in the format most effective for their activity, independent of the physical proximities of the various parties. Students will be required to understand this communications network whereby the coded information is transported through wire, air, and/or fiber optics, and the capabilities of various terminal equipment (video displays, printers, personal computers, and so on) to enter information into and extract information from this communications infrastructure.

Strategic Reasoning Skills

The second major substantive issue inherent in K–12 curriculum development for the near future is the teaching of higher-order reasoning skills. As knowledge will be the capital upon which tomorrow's investments will rise or fall, and access to information or to specialized data bases is the mechanism by which knowledge can be used most productively, futurists have persuasively argued that the higher-order reasoning skills of application, analysis, synthesis, and evaluation will be the basic thinking skills of tomorrow.

Moreover, the traditional reasoning models, of the logical deductive type, will not be as critical as before. What will count most in the information age is the capacity to intuit from relatively large amounts of new information those "chunks" of information that can be related usefully to other kinds of information or to a knowledge base already stored in the brain. Reasoning skills that students can apply to the relational nature of new information and old knowledge will be at a high premium.

In the logical deductive models, reasoning is systematically structured from the general to the particular. To illustrate, once problems have been identified and defined, goals are clarified, obstacles to goals are identified, alternatives to obstacles are generated, the probable consequences of each alternative are examined, and a *best* solution is found, tried out, and evaluated. At each stage of the problem-solving sequence, progress depends on the effective application of general principles pertinent to the particular problem situation.

In the intuitive or inductive reasoning process, new facts, data, or information bits are related to an already developed knowledge domain or to the working memory, and new, yet incomplete, wholes are formed. Thus problems are tentatively solved and decisions tentatively held because they make the most sense given the amount of information at hand.

Because large blocks of unfamiliar information will be generated and accessed regularly, the information must be [illegible]d, processed, and retrieved effectively for given purposes. People's ability to use information in this way will depend largely on the knowledge and information bases they have accumulated in their working memories and in part on their ability to access other data bases relevant to problem situations.

Continued on p. 67.

Continued from p. 39.

Thus the teaching of intuitive or inductive reasoning becomes a high priority proposition for the schools. The reasoning skill is not content-specific, but rather it cuts across the conventional disciplines. Teachers will want to promote inductive reasoning skills by mimicking their applications in everyday life. Mnemonic association and "chunking" information are two suitable instructional techniques. The former trains the long-term memory to recall new information by linking it to bits or pieces of old information. The latter trains students to organize new and relatively large amounts of information by relating selected parts (chunks) of it to "domain-specific" knowledge or to information previously mastered.

Some K–12 intuitive reasoning competencies defined by the Network and that might be targeted in all or most of the traditional subjects follow:

The student will transfer new information from the short-term memory (30–60 seconds) to the long-term memory through mnemonic association.

Given a series of digits or random numbers of 10 or more, the student will recall the numerals through mnemonic association.

The student will organize new information by relating its specifics to domain-specific knowledge or to the working memory; that is, a relatively large set of relevant facts already known about the subject matter.

Given blocks or chunks of new information, the student will link it to information or knowledge stored in the working memory by at least two mnemonic strategies; that is, ways of linking or interconnecting new information to old.

Given facts, information, or knowledge, and practical situations/experiences that are poorly defined and characterized to an extent by irrelevant information, the student will identify the specific facts or chunks of information that are relevant to solving the problems or coping with the situations.

Given unfamiliar problem situations, the student will make intuitive decisions supported by the given information.

Given substantial information and knowledge related to real life problems, the student will identify seeminly far-fetched or improbable but potentially innovative and effective alternatives to the problem solution.

If knowledge and expertise will be the key determinants of success in the information age, the kind of reasoning skills that can make efficient, sensible use of new and relatively large amounts of information related to knowledge domains will determine the kind of problem solver, decision maker, or information processor that students will become. The schools can fairly take that proposition as a "futures" mandate for effective instruction.

Once futures curricula have been defined (a one- to two-year developmental process for a beginning), and those definitions accepted by the majority of professionals staffing the schools where they are intended for use, the final three phases of development and implementation can proceed.

Phases 3 Through 5

Phase 3, *developing instructional methodologies, materials, and procedures*, can involve the largest number of teachers in the most productive ways. Perhaps the outstanding problem will be persuading subject matter specialists at the high schools to *infuse* the concepts of Information Technology, Intuitive Reasoning, Change, Artificial Intelligence, Life Planning and Development, and Human Relations into the regular instruction. "I teach science," the science teacher may argue, not information technology, not reasoning skills, not change. During this phase the development of exemplary infusion practices that integrate the specialized concepts with regular subject matter, and that teachers can use in the classroom, can make a telling difference.

Of "futures" instruction generally, school district and school site managers should recognize the need for a multifaceted and integrated approach. Infusion, new courses, identified minimal and graduation standards, and so on, can all be used effectively to expedite implementation.

Phase 4, *constructing competency tests* of student proficiency, or alternative assessments of same, is largely a technical phase that can occur concurrently with the building of the instructional components and might best be assigned to professional test developers with staff review.

Phase 5, *implementation*, begins the actual use of the curriculum, instructional, and assessment products in the designated schools and classes. Implementation is best accompanied by two support operations, formative evaluation and staff development.

Formative evaluation is a technology intended to improve developing programs throughout the course of their development. The process involves monitoring implementation plans and progress testing to determine how well programs are moving toward final objectives and, more important, in what ways they might be improved in the future.

Staff development is a critical function in the development schemes of "futures" education, and might assume numerous forms. Teacher involvement at the earlier developmental stages, on as broad and diverse a scale as makes sense in the local schools and districts, should pay handsome rewards when full-scale implementation begins. By involving teachers in development activities, ownership of the developed products will be enhanced, and the training key teachers obtain can be systematically passed along to others. Information sessions intended to clarify the curriculum products and the associated instructional/assessment products are essential and useful, for both teachers and administrators, but are not enough.

Timelines for all of this activity should not be underestimated. Districts and schools that can accommodate themselves to a developmental timeline extending across approximately five years will be more likely to produce demonstrably effective futures education programs and successfully move their students into the country's near future. □

Network Representatives

ABC Unified School Dist.
Cerritos, Calif.

Edmonton Public Schools
Edmonton, Alberta, Canada

Fullerton U.H.S.D.
Fullerton, Calif.

North Orange County J.C.P.
Anaheim, Calif.

Novato Unified School Dist.
Novato, Calif.

Ocean View Elementary School Dist.
Huntington Beach, Calif.

Redondo Beach City School Dist.
Redondo Beach, Calif.

Rowland Unified School Dist.
Rowland Heights, Calif.

San Dieguito U.H.S.D.
Leucadia, Calif.

Sweetwater U.H.S.D.
Chula Vista, Calif.

Whittier, U.H.S.D.
Whittier, Calif.