MicroWorks: ISI's New Educational Program Prepares Your Child for the Information Society

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The spread of the use of computers has been nothing short of breathtaking. It is doubtful that even the most optimistic of experts could have foreseen how rapid the proliferation of computers would be. Even after the introduction of UNIVAC I and the development of transistors, few could have predicted how quickly microcomputers would enter virtually all sectors of society. But computers today play a pervasive role in everyday activities of society. In fact, the economy of the entire world is becoming increasingly dependent on the ease and timeliness with which information can be transferred via computers. Nowhere is this more evident than in the field of education.

We are currently in a transition from an information-conscious society, in which "people realize the importance of rapid access to information...[but] do not necessarily have [it]," to an information society, characterized by "rapid and convenient delivery of needed information [as] the ordinary state of affairs."[1] To develop and thrive in the information society, people will need to possess more than minimal levels of skill with computers. However, Ed Feigenbaum, chairman, Computer Science Department, Stanford University, California, and coauthor of the book, *The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World*,[2] disagrees. He believes that artificial intelligence and increasingly user-friendly software will actually make fewer demands on computer users of the future.[3] In either case, though, people will need to become "computer literate."

For many noneducators, computer literacy implies an ability to analyze and solve problems through the appropriate application of computer technology. As Jim Hall-Sheehy, director, education and data-processing, American General Corporation, Houston, Texas, characterizes it, computer literacy means being able to think with computers.[4] Beth Eddinger Wesley, Gerald H. Krockover, and Charles R. Hicks, Purdue University, West Lafayette, Indiana, note that "without some form of computer literacy, many individuals will be excluded from present and future job markets."[5] We will explore this subject further in a future essay on science literacy.

The Spread of Computers in the Schools

With the importance of computers in society increasing, it is not surprising that they are playing an increasingly important role in the education of children around the world. In the UK, for example, according to figures compiled by Ifan D.H. Shepherd, School of Geography and Planning, Middlesex Polytechnic, UK, computers have been installed in about 6,500 secondary schools and 27,000 elementary schools.[6] In the US, microcomputers have been installed in over 50 percent of the classrooms for grades kindergarten through 12 in over 1,000 schools studied by the National Survey of School Uses of Microcomputers.[7] And in the Soviet Union, a major program was launched in 1985 to teach computer skills to all secondary-school students.[8] The program is called "Principles

of Information Science and Computer Technology." According to Stephen T. Kerr, University of Washington, Seattle, it is intended to promote "an all-around deep mastery by young people of computer technology."[8]

Moreover, instruction in computers has become a major public-education issue: the US National Commission on Excellence in Education, for instance, recommended that one-half year of instruction in computer science be added to the nation's local and state requirements for graduation from high school.[9]

Computer Literacy and Computer-Assisted Instruction

Educators are taking several approaches to the incorporation of computers into elementary and secondary schools. One such approach is labeled "computer literacy," but to educators, this implies a very specific curriculum rather than a general familiarity with the use of computers. This curriculum includes learning to write programs, learning about computer operations and hardware, and instruction in computer awareness that focuses on the potential of computers in society.

Another approach to implementing the use of computers in elementary and secondary schools is called computer-assisted instruction (CAI), which stresses educational experiences that use computer software to teach specific subject areas. In at least one form of CAI, students use various types of software (such as educational games or tutorials) to help them gain skills in particular areas, such as arithmetic or vocabulary. The software presents repetitive lessons in a "fill-in-the-blank" format; students enter a value into a sentence or equation and are then told by the computer whether the reply is correct.

ISI's *MicroWorks: Tools for Learning*

For the past decade or so, educators have largely emphasized learning a programming language or using computers as electronic worksheets for elementary- and secondary-school students in the US. But these experiences do not help students acquire the knowledge and skills they need to work with computers in real-life situations.[10] And, as noted by Diane Ravitch, Columbia University, New York, students also need to learn how to use computers during the natural course of preparing their academic work.[11]

In connection with our tradition of serving professional scientists, we at ISI® have often wondered about ways of bridging the gap between the worlds of the academic scientist and of the teacher of science or others interested in science. Our latest endeavor in this regard is *THE SCIENTIST*™, a newspaper for the science professional that provides information on the business of science.[12]

We have also taken a keen interest in helping the younger generation prepare for their future roles as knowledge seekers. One means of providing such help is through science books for children, a subject we reviewed a few years ago.[13] Another method, identified by many educators, is introducing children to the use of computers in real-life applications. Our experience with *SciMate*® [14,15] gave us expertise in software development that we applied in creating *MicroWorks* for students from kindergarten through the ninth grade. In creating a program that uses software to teach course content in a wide variety of subject areas, we consulted with J. Weldon Greene, director, Program Development and Planning; Jenelle Leonard, director, Computer Literacy Training Laboratory; and Joseph Harris and Shirley Bellamy, all of the District of Columbia Public Schools. The program, entitled *MicroWorks: Tools for Learning*™, was coauthored by Peter Scharf, Department of Education, University of Pennsylvania, Philadelphia, and John Chattin-McNichols, Seattle University, Washington.

MicroWorks: Beyond Computer Literacy

MicroWorks defines a new approach to the use of computers in education. It uses applications of computer technology—such as

Figure 1: An edited example from the *MicroWorks: Tools for Learning*™ activity on "Earthquakes," showing the first page of the students' worksheet.

INTRODUCTION

The global pattern of earthquakes has helped us understand the evolution of mountain ranges, continents, and oceans. Engineers consult this same global pattern before planning the construction of large structures such as buildings, bridges, and dams.

You will generate a hypothesis about the worldwide distribution of earthquakes, and you'll use a database to help you support or refute your hypothesis.

YOU WILL NEED

☐ computer
☐ database software
☐ datafile disk with files USQUAKE and WDQUAKE

1 *Be sure to read these directions before you move to the computer. Review or check with your teacher if you don't understand something. Have Part A of the "Earthquakes" worksheet ready.*

1. Load the database software.
2. Load the datafile USQUAKE.

• To better understand the database, read the sample record below.

Place	_____
Date	_____
Intensity	*In Mercalli scale, written in integers equivalent to the Roman numerals.*
Death toll	*How many people died?*
Near ocean	*The nearest ocean - Pacific, Atlantic.*
Comments	*Some characteristics of the earthquake.*

3. FIND earthquakes in California since 1800.
    FIND place = California
           and
          date > 1800

   How many?_____

word processing, spreadsheets, and database searching—to enhance thinking and analytical skills while helping students learn course content in a wide variety of subjects. Moving beyond drill-and-practice software, *MicroWorks* enables students to use computers in the course of their regular lessons. The goal is not only to aid students in their lessons and promote an understanding of the capabilities and limitations of computers, but also to enhance the development of their reasoning skills in science, mathematics, language, the arts, and social studies.

To ensure that *MicroWorks* is a relevant, effective program, we collaborated with teachers and students from 20 school districts around the country, including the District of Columbia; New York City and State; Detroit, Michigan; Chicago, Illinois; Newark, New Jersey; Cleveland, Ohio; and San Mateo, California. Thus, while the *MicroWorks* databases have been compiled with the benefit of ISI's 30 years of experience in creating databases, the specific techniques and approaches of information retrieval in *MicroWorks* are closely matched to the requirements of schools and the needs and abilities of students.

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MicroWorks: Program Contents

Currently, *MicroWorks* consists of 14 subject areas, or modules, that supplement classroom study in creative writing; composition; literature; grammar; geography; history; the life, physical, and earth sciences; and practical and theoretical mathematics, including pre-algebra. Student materials for each subject consist of an activity book, software, and data files. A few examples of the data files included in the program are "Earthquakes"; "World Geography," with data on 100 countries; "Delegates Database," consisting of data on the delegates to the Constitutional Convention in Philadelphia in 1787;[16] and a "Pollution Database," with data on pollution in 84 US cities. Teachers' materials include comprehensive manuals and instructional materials. The software includes the integrated word-processing, database-management, and spreadsheet programs; the *MicroWorks* Datafile Disks come preloaded with the information the students need to complete the lessons in the activity book. The *MicroWorks* package also includes loading-instruction booklets that tell how to run *MicroWorks* on various machines; six posters that illustrate the step-by-step loading instructions; and pre- and posttest forms for assessing students' comprehension and skills.

Teaching with *MicroWorks*

MicroWorks can be used by elementary-school students in a variety of educational environments. Some schools have developed computer labs in which students participate in the *MicroWorks* program either independently, collaboratively in small groups, or as an entire class. Other schools have computer learning centers directly in the classrooms, where students can work together or individually on activities. Most activities are designed to be performed with a partner and can be shared with the entire class.

After classroom instruction is offered in a particular subject, students are assigned a related activity from the *MicroWorks* module. The first part of the activity, called "Getting Ready," reviews concepts necessary for the lesson and is done in the classroom. Students are generally directed to complete a worksheet before moving on to the computer, although some activities require group or class participation or ask students to do some outside reading. An edited sample of a worksheet, from the activity on "Earthquakes," is shown in Figure 1. The worksheet instructs the student to develop a hypothesis about the occurrence of earthquakes in different parts of the world.

Each activity has three lessons, called "On the Computer" 1, 2, and 3. The first lesson typically introduces a data file that contains subject information retrievable by standard search techniques. (It may also ask the student to use a word-processing or spreadsheet program to manipulate information retrieved from the data file; edited examples of activities that teach word-processing and spreadsheet skills are shown in Figures 2 and 3, respectively.) The more advanced lessons ask students to perform progressively more challenging tasks with the skills learned in the first lesson.

In the "Earthquakes" activity, for example, students are asked to explore the costs to society of cities located in the unstable geological zones around the Pacific rim—the so-called "ring of fire." The first computer lesson asks students to predict where earthquakes will occur in the US. The second and third computer lessons ask them to generate hypotheses about the relationship between earthquake intensity and damage using a database that shows earthquakes around the world.

The final section in the *MicroWorks* activities, called "Thinking It Over," asks students to reflect on the skills and knowledge they've gained and links the experience from that activity to other lessons and to classroom instruction.

### *MicroWorks* in the Schools

To help educators integrate *MicroWorks* into school curricula, ISI has been working with teachers and administrators in field-testing sites in 15 school districts around the

Figure 2: An edited example showing the *MicroWorks: Tools for Learning*™ activity on "Changing the Point of View." Students use a word-processing program to change the viewpoint of samples of text from first person (a story told from the narrator's point of view) to third-person omniscient (in which the narrator is outside the action of the story). Word-processing software enables the user to electronically create, format, and edit text and print the result.

INTRODUCTION

You will use your word-processing software to change the point of view for three different pieces of writing.

DIRECTIONS
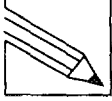
1. Together with your partner select a sample sentence(s) from selections in your textbook written from the following points of view.

   a. first person (told using "I")
      Sample Sentence(s): _____
      Title of story: _____

   b. third-person omniscient (told about him, her, and them knowing about everything)
      Sample Sentence(s): _____
      Title of story: _____

2. In third-person omniscient, the author reveals the actions and thoughts of any and all characters. In third-person restricted, the author limits himself or herself to the actions and thoughts of one character. Read each example below. Identify the point of view: third-person omniscient or third-person restricted.
   Then explain your choice.

* The roar in the stadium went silent as the injured player was taken off the field. The coaches and teammates hoped against all hope that the injury would not end the rookie's brilliant career. But they soon found out Mike Rawling would never play again.

Why? _____

Be sure to read these directions before you move to the computer. Review or check with your teacher if you don't understand something.

1. Load your word-processing software.
2. Load the datafile PERSON.
3. Working separately, you and your partner take turns and use the word-processing program to change each piece of prose as follows:
   * Change *The Great Gatsby* from first person to third-person omniscient.
   * Change *The Christmas Parade* from third-person omniscient to first person.
4. Save your work PERSON2 on to your data disk.
5. Print out a hard copy.
6. Exchange your work with your partner. Check to see that the point of view is the same throughout. If not, let your partner know so he or she can change the text.

country, including the District of Columbia; Trenton, New Jersey; and Boston, Massachusetts. Evaluations from those who have tested the *MicroWorks* program have contributed valuable insights into how it might be improved. The overall response has been extremely positive, but since most school districts do not permit teachers or administrators to endorse a product (or give the appearance of doing so), we are unable to quote these comments. Typical of many of the remarks, however, is that *MicroWorks* helps prepare students for the world beyond the classroom.

Figure 3: An edited example showing the *MicroWorks: Tools for Learning* "Cities Spreadsheet" activity. Students use a spreadsheet program to calculate various population parameters for several cities and construct a profile of each city. Spreadsheets enable users to prepare and update reports that contain numerical data. They are electronic representations of accountants' ledger sheets. The intersection of each column and row (known as a cell) is assigned a unique identification. Formulas as well as data (number values) can be entered for each cell; the formulas operate on the data to give results.

INTRODUCTION

You will use formulas to complete data for a spreadsheet and then construct a "city profile."

Be sure to read these directions before you move to the computer. Review or check with your teacher if you don't understand something. Have the "Cities" worksheet ready.

1. Load the spreadsheet software.
2. Load the datafile CITYSP.
3. Cell E,2 contains a formula to calculate the number of people per library (People/Libraries).
   a. COPY the formula from cell E,2 to the next 7 cells in column E (*E,3 through E,9*).
   b. Set the program to **calculate**.

From an educator's point of view, one of the advantages of *MicroWorks* is that it supplements the school curricula by introducing significant scientific information in the classroom for the student to manipulate. But from the students' point of view, its primary advantage is that it's fun! Several teachers reported that they virtually had to evict students from the computer labs (although it should be noted that such an enthusiastic response has been noted following the introduction of other educational innovations as well). Student evaluations of *MicroWorks* were in almost unanimous agreement that *MicroWorks* is enjoyable as well as educational. Several students noted that some of the activities were harder to perform than others, but they said they liked the challenge and were especially pleased when they accomplished a task without the teacher's help. A few proudly announced that they were helping their classmates over some of the rough spots.

One student especially appreciated the activities that employed word processing because she liked being able to correct her mistakes. She and many other students also particularly enjoyed the spreadsheet applications in budgeting and shopping for clothes and food, commenting that it was fun to learn things that had relevance in the real world.

Preparation for Life

MicroWorks in itself does not provide the basic motivation to achieve or succeed. That comes from teachers, parents, and society, but it is also something that, at least in part, children must develop on their own. In developing *MicroWorks*, our aim was to create a program that would allow students to progress through activities at their own pace, develop self-confidence, and gain a sense of accomplishment. But perhaps more important, our goal is to give students a sense of *process*, a way of approaching problems and seeking solutions. This, as the students themselves stated, is preparation for life.

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