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ABSTRACT

In the fall of 1990, seven teachers at the Ralph Bunche School, a public elementary school in Harlem (New York) began an experiment in school restructuring they called the Computer Mini-School. An unexpected outcome of the project was an increase in standardized test scores among their 120 students. This outcome is explored. It is argued that the greater sense of stability and community that the program brought about was a contributing factor. The background and history of the project are traced. Students and teachers developed a tradition of staying outside school hours, in many cases adding to the instructional time available. A whole language approach to literacy was used, and computers were used extensively for student writing and a student newspaper. From the experiences of the Ralph Bunche School, the following principles for design of a project-based school are presented: (1) students and teachers take increasing responsibility; (2) workplaces are the units of work and communication; and (3) connecting the local area network and wide area networks, such as the Internet, is very useful. The sense of community and emotional belonging that became possible with the smaller class sizes, educational technology, and teacher sense of ownership were probable contributors to improved achievement test scores. Two figures illustrate the discussion. (Contains 5 references.) (SLD)

CENTER FOR TECHNOLOGY IN EDUCATION

The Ralph Bunche Computer Mini-School: A Design for Individual and Community Work

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Standardized tests are a common basis for deciding how well schools are doing. When a group of teachers conducts an experiment, such as a new curriculum program or a new school-within-a-school, administrators look to the end-of-year tests to help them decide whether to continue supporting the experiment or to move attention and resources elsewhere. In the fall of 1990, seven teachers at the Ralph Bunche School, a public elementary school in Harlem, began an experiment in school restructuring that they called the Computer Mini-School. At the end of the school year, they were pleasantly surprised by the test scores of their 120 students. The district administration grandly congratulated the team and committed support for continuing the experiment.

An increase in test scores was not an expected outcome. In fact, although the teachers had been somewhat apprehensive about how the students would score, they had not done anything different from the previous year to specifically prepare students for the tests, which were administered over a three-week period in April. While the Computer Mini-School had a very active computer program, the use of computers was not at all designed to foster improvement on the test scores. On the contrary, with the emphasis on collaborative projects and integrated curriculum, the work in the computer lab precluded the kind of drill-and-practice software that is often sold as a means for improving test scores (Newman, 1992).

This paper explores the unexpected outcome of higher test scores. Based on our observations of students' work and engagement in learning, along with some of the reasons that teachers gave for the improvement, we argue that the changes were based on a greater sense of stability and community for the students in the Computer Mini-School. We then describe a design for the integration of technology that is geared toward helping to support that community. We do not claim any direct effect of the technology on the test scores. But if a greater stability and sense of community are positive factors, we can ask how technology can help to foster them.

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Background and History of the Computer Mini-School

The Ralph Bunche School is a third to sixth grade public school in Central Harlem's Community School District Five. The majority of its 750 black and Hispanic students live in the neighboring public housing. Most of the students meet many of the criteria of low income and other measures of poverty. There are six special education classes in the school, one Spanish-English bilingual class, and two Haitian-English bilingual classes.

Six years ago, a few teachers at Ralph Bunche School, in collaboration with researchers at Bank Street College of Education, began a project to design a local area network system, called Earth Lab, that could support collaborative science investigation among elementary and middle-school students (Newman, 1990; Newman, Goldman, Brienne, Jackson & Magzamen, 1989). The local area network (LAN), which connects all the computers in the school, provides electronic "workplaces" that are available to the students anywhere or any time that the students work at a computer.

Teachers directly involved in the Earth Lab project found that their own approach to teaching was changing, and that students were taking a greater initiative in learning. For example, here is just one of many vignettes illustrating a student taking charge.

> Natasha, "senior" editor of the school newspaper, is in a dither. She has just finished opening the electronic mail for the newspaper, and one of the students hasn't mailed a promised article about their class Grow Lab (a classroom greenhouse and gardening project.) She types and mails a quick reminder to the student. In the next few days, Natasha and her staff will review all the submitted articles, scan submitted artwork, and move the files from the Apple II computers to a Macintosh computer where they will use PageMaker to do the final layout.

Students continued to develop their personal workplaces from one year to the next. Teachers began using workplaces for projects that spanned multiple years. Thus, the technology not only provided continuity for development of their own teaching techniques, but also gave students a sense of continuity in their own work. The workplaces were also used very flexibly, allowing teachers to create a workplace for a brief one-time project or work group that functioned for only a few days or weeks.

In 1990, building on the Earth Lab experience and with parental backing, seven of the teachers initiated a Mini-School within the school to develop and extend the collaborative and cross-curricular approaches to learning that were becoming evident in the use of electronic workplaces. Students participating in the Computer Mini-School were selected by lottery. Teachers voluntarily gave up free periods—which had been contractually guaranteed—in exchange for smaller classes. They used support services for remediation and enrichment more effectively by bringing services into the classrooms rather than fragmenting the students' day with pull-out programs. As a result of this further restructuring, classes in the Mini-School had between 19 and 23 students, while classrooms in the rest of school had 28 to 37.

With the advent of the Mini-School, teachers moved to one floor of the building. A climate of collaboration and social contact developed which encouraged students and teachers to stay after school and work informally together. Students and teachers frequently had the opportunity to work together as peers or even to reverse student-teacher roles. For example, it was not uncommon to see students helping the less technologically-experienced teachers with computers.

Before and after school, students also assisted with some of the routine record-keeping tasks, such as recording the marks of weekly spelling tests in a computer database. The extra time was frequently used to finish special projects, such as editing the school newspaper. In the second year of the Mini-School, the tradition of working outside of regular school hours led one of the teachers and her whole class to voluntarily stay after school every day for a period in the spring for extra math work. Clearly, this extra math work will help to improve the test scores for the school, but what is important about this extra work is that it arose from a sense of community, not from any requirement.

Although the teachers remained officially accountable to the principal and school administration, a sense of collective accountability developed. The teachers planned together for the use of scarce resources. Several teachers shared their expertise and experience with whole-language approach to literacy, and the group worked together in selecting children's literature rather than basal readers. A collaborative project-based approach also continued to develop in math and science.

The following vignette illustrates the kind of math work students accomplished together:

> Before the school day officially begins, three sixth grade students locate the current issue of *The New York Times* in the computer room. One of them, a student mentor, shows the other two how to use the sunrise and sunset information recorded there to calculate solar noon. The students have established their own tradition—a student will learn how to perform the calculations from a student mentor and, in turn, will become a student mentor. They calculate solar noon, enter the preliminary data in a computer database, and dash off to their regular class. At solar noon that day, the students carry a tripod and meter stick to the schoolyard and take shadow measurements. These new data are added to the database. The teacher reminds the students to send a copy of their findings via electronic mail to the students in Boston, Sweden, Australia, and several other locations where students are taking similar measurements.

Teachers accepted the responsibility for assigning students to their new classes for the next academic year. They felt that their personal knowledge of individual students and of their colleagues' individual teaching styles formed a basis for making class assignments that was superior to the method used by the rest of the school, in which students are grouped on the basis of their reading and math standardized test scores.

The benefits of the Mini-School now extend beyond the school itself. Parents are more involved in their children's work, and many parents come to the school to use the computers. As a result of this increased contact, one mother decided to participate more formally with the students and is now serving as a paraprofessional in the school. Other parents are pressing the administration to have their children placed in the program.

The benefits also encompass the emotional and social dimensions of school life. For example, a number of students who had difficulty adjusting to school in the past are beginning to develop positive work and social habits. Many students, who in a more traditional setting would have been placed in a special education program because of emotional and learning difficulties or sent to the main office for discipline, are able to remain in a regular class. The climate of collaboration fostered by the school have helped support these students. Consider the following vignette:

> At 10:30 Keesha enters the computer room crying. Stevon is not far behind. After a short reassuring hug from the teacher, the story begins to unfold. "He hit me and then . . . and I hit him back. Yesterday, in the yard . . ." On it goes. The teacher invites Stevon to explain his side of the story. It becomes clear that the problem has a complicated history that goes back several days. The teacher instructs the combatants to write an incident report and send it to her on the local area network. Ten minutes later she finds both students working at adjacent computers, carefully checking each other's versions and negotiating revisions to insure a completely accurate account of the problem.

The experiment is continuing now into its third year. Two more teachers have joined the Mini-School. Parents continue to make the Mini-School their first choice. The test scores also continue to improve at a faster rate than in the rest of the school. Researchers from Bolt Beranek and Newman Inc. and Columbia Teachers College are now working with the teachers and students, providing some additional resources for science and language curricula. For the most part, however, the changes that have occurred have come directly from the teachers. Beginning in the spring of 1993, a new project will again use the Ralph Bunche School as a source of expertise in applying technology to organizational change as well as a testing ground for new networking technology. Picking up where the Earth Lab project left off, the Copernicus Testbed will be developing an approach to managing more effectively the network technology in a community such as the Computer Mini-School. The final section of this paper outlines the major thrust of this technology redesign.

The Test Results and What Helped Students Improve

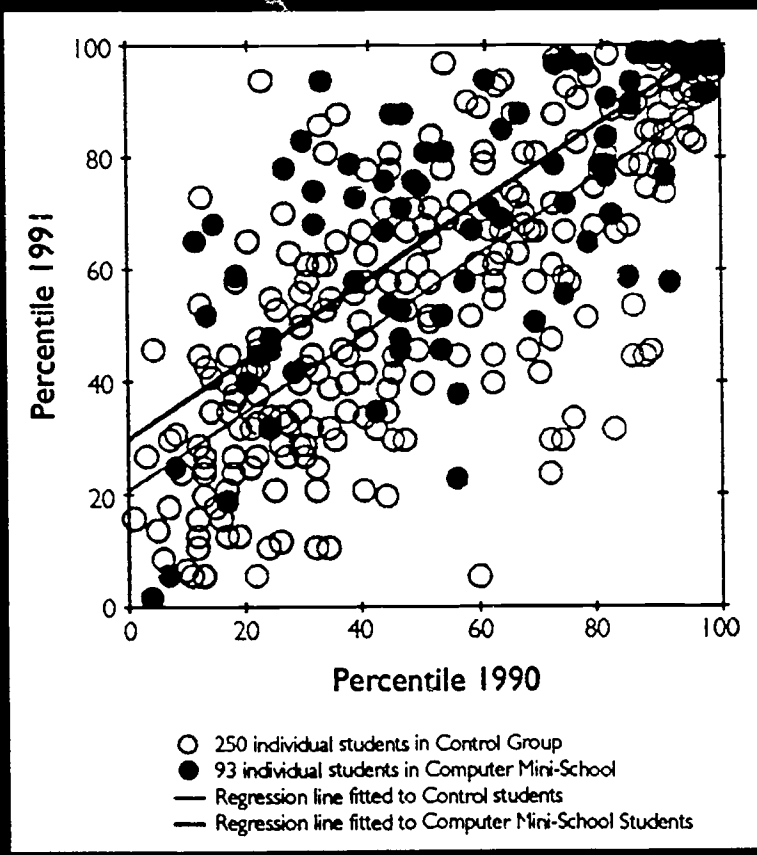
New York City administers a rigorous set of tests to all students in the late spring. The results make the front page of *The New York Times* (e.g., Berger, 1992) in stories that critique policy decisions presumed to result in the rise or fall of test scores. After the first year of the Computer Mini-School, the test scores for the city schools had generally improved. Even with this general improvement, the scores for the children in the Mini-School stood out as showing a greater improvement compared to the rest of the district.

Researchers involved in the implementation and observation of design experiments analyzed the raw test results in order to see whether the results actually stood up to statistical analysis and whether such analyses could uncover any hypotheses as to the cause. The issue was to determine whether students in the Computer Mini-School (the experimental group) improved more in their reading and math skills than comparable students in other classes (the control group). Consistent with the results reported in the Times, the scores for both groups improved from 1990 to 1991. The question is whether the Computer Mini-School students increased significantly more. We worked with the 1990 and 1991 test scores for the students at Ralph Bunche School selecting those for whom math scores (345 students) and reading scores (304 students) were available for both years. Four tests were available: one reading test and three math tests covering "Concepts," "Problem-solving" and "Computation." In all cases, the dependent variable was the 1991 performance. Results are expressed in terms of percentiles.

For each math subtest, the analysis of covariance showed that the improvement of the experimental group was between 8.7 and 10.6 percentile points larger than for the control group. The effect was highly significant in each case[1]. For the reading scores, the results were less spectacular. The experimental group improved about 2.9 percentile points more than the control group, but this difference was too small to be significant.

The results for the combined math scores are shown in Figure 1. The graph shows a scatter plot for the two groups of students, those in the Computer Mini–School (filled points), and others (open points). The fact that the double line, representing the Computer Mini-School students, lies above the single line, for the others, shows that the Computer Mini-School students improved more than the others by about 10 percentile points, and that this difference was about the same for both good and poor students. In other

Figure 1: Combined Math Scores



words, the differences at least for math were real and quite substantial.

Numbers, however, do not explain the dynamics behind the results. We asked the teachers for their interpretations of the results. Clearly, the teachers who joined the experiment were motivated and experienced a sense of empowerment in being able to reorganize their work setting. A fundamental small groups, whole classes and in school-wide organizations reinforcing a project approach to learning. In brief, the network organization enabled teachers and students to build a sense of a community that could learn together.

Is creating a better classroom and school community a possible design goal for technology? In most work on the social effects of technology, the results have been an incidental effect of technology, not something the technology was specifically designed to support. If creating the community is an effective method for improving academic results, we should begin moving our attention from content-based courseware and tools designed for individual work to systems that support communities. The initial design of the Earth Lab technology was intended as a support for collaborative work. In the next section, we describe some of the critical features of the technology design and how it is used in the Computer Mini-School community.

What Technology Makes a Difference? Present and Future Design

The technology that underlies the Earth Lab system at Ralph Bunche is a local area network (LAN) connecting all the computers (currently, 60 Apple IIs and 14 Macintoshes) in the school. The LAN, coupled with a network file server, allows flexible access to files (including data, text, reports, diagrams) across physical contexts (classroom, computer lab, library, home) and time frames (periods, units, grades). In essence, because files can be stored and retrieved from a file server on the network, it becomes possible to make those data available wherever the student is working. This makes project work more flexible and provides a sense of unity to the work, which is no longer tied to a particular time and place. The environment contains a variety of word processing and database, desktop publishing and other tool software, including electronic mail, which connects students and teachers both over the local and wide area networks. The school's computer network has expanded to include two separate labs, a satellite lab in a small room off one of the classrooms, and networked computers in several other classrooms.

The primary means for supporting project work and flexible access to computer resources in Earth Lab is what we call "workplaces," which are folders on the file server in which the work of the project, in the form of text, database, graphics, and code files is stored. These workplaces, available to any computer on the school LAN, give groups a location for their work together. Figures 2 and 3 show the workplaces available to one sixth grader in the early fall of 1991, both at the school-wide level and within her class. At the school-wide level, workplaces are set up to serve school-wide clubs or other projects, such as Kid Witness News (KWN), a group involved in video production. Each individual also has a personal workplace within the classroom folder. The science work groups give themselves names that are used for group workplaces. Students share different data with different students or groups in the school; for instance, a science group, a noon-hour club, and the whole class.

We find that with this approach to the use of a school LAN, teachers are better able to collaborate, students are better able to carry their work from one context to another, and the computer lab is increasingly used in a heterogeneous manner, with several projects or groups from different classes working simultaneously.

Even when the computer lab is scheduled for whole-class instruction, workstations remain free for individual and small-group projects. The lab is recognized as an activity space open to all, rather than as a classroom to be scheduled for the exclusive use of one group. In a typical hour, we saw a fourth grade class use Scholastic's Hyperscreen to illustrate ideas from a book they were reading. Shortly after the class began work. the two weather monitors from one of the fifth grade classes slipped into the room, checked with weather instruments, and entered the data in their class database. Later in the period, a student teacher found a free computer to retrieve some information from a nutrition database.

The way the project workplaces are set up for groups and individuals helps to develop a sense of continuity. For example, several students from differ-

Figure 2

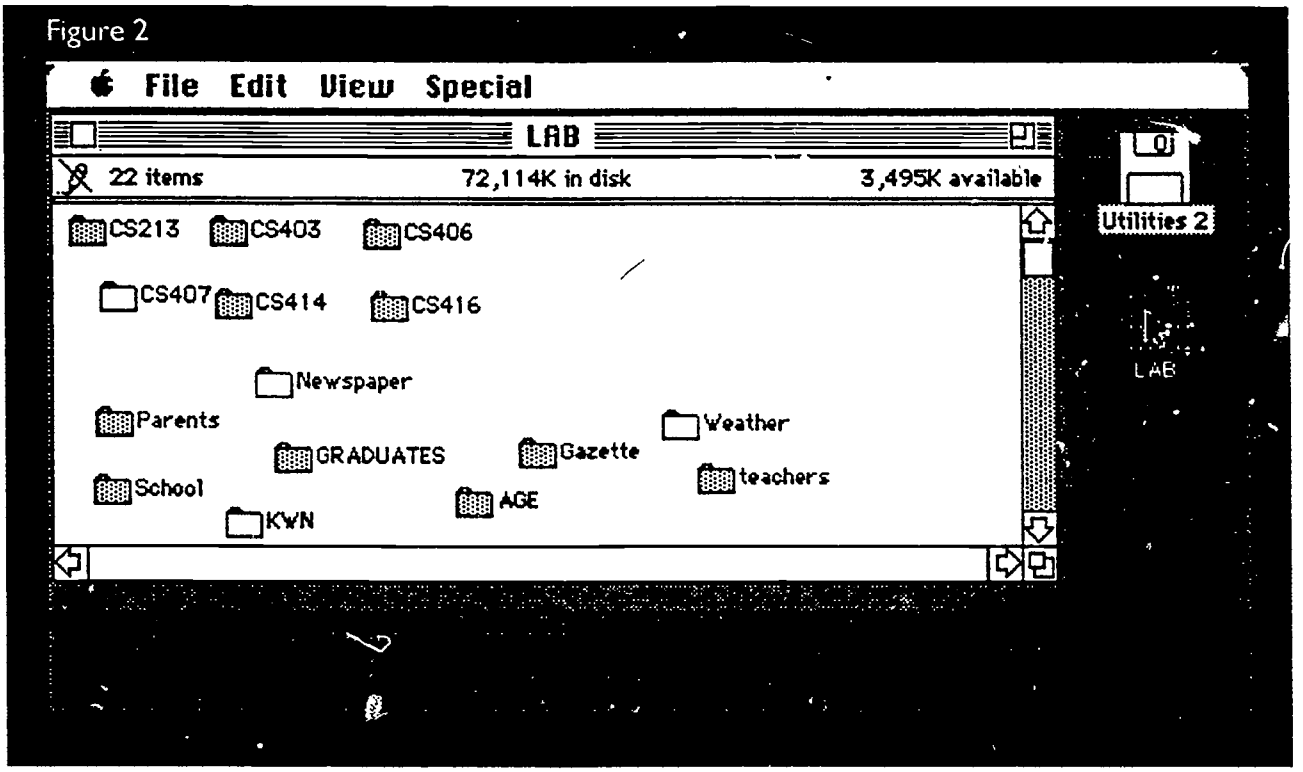
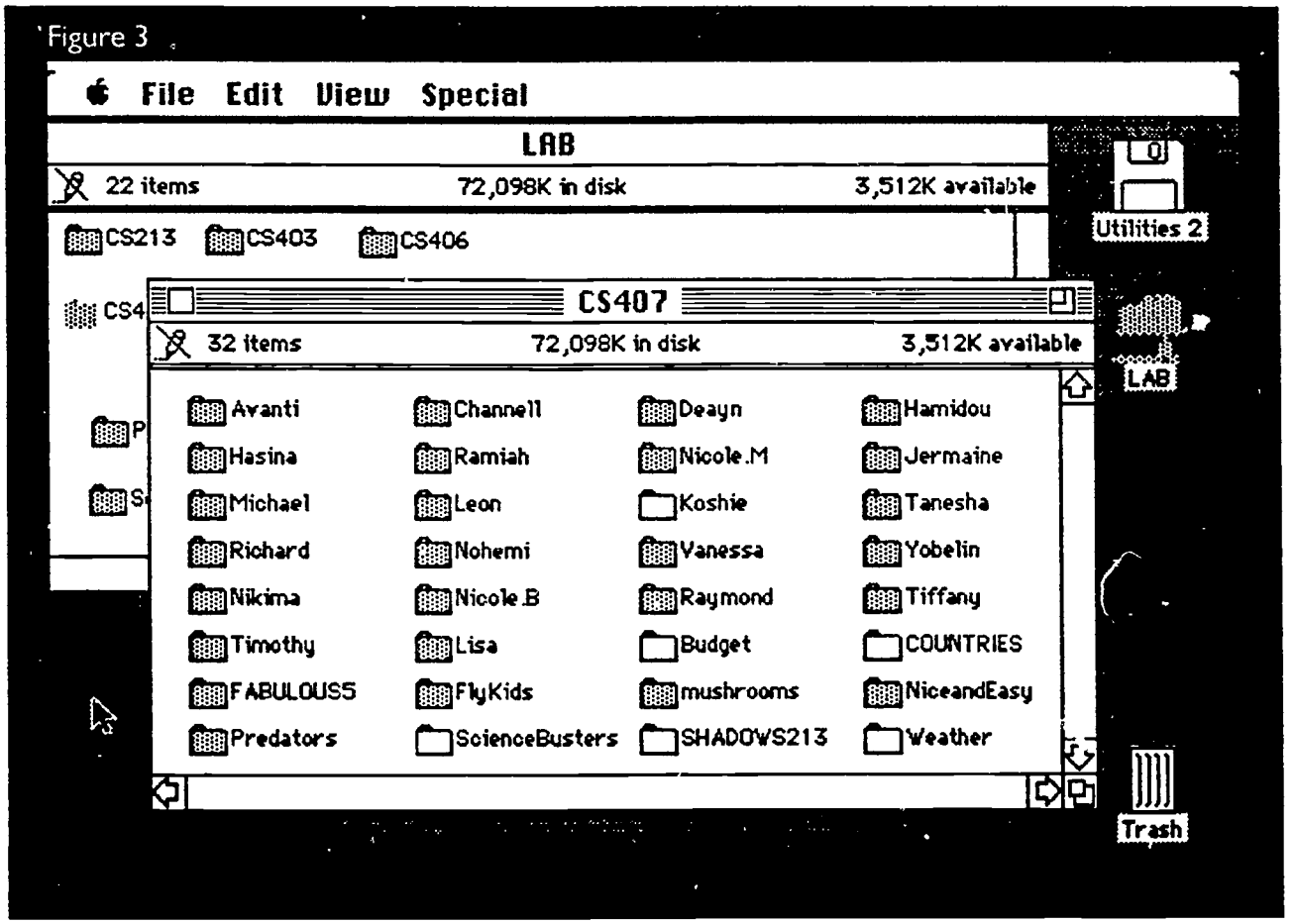


Figure 3



ent classes and different grades are editors for the school newspaper. The newspaper has a workplace on the network that students use for storing articles and other material for the newspaper. Beyond the editorial group, many students around the school contribute articles to the newspaper by sending them as messages through the electronic mail system to the editors. The common workplace makes it easy for the editorial group to work at different times and places on the newspaper. The network makes the walls between classrooms more permeable. The ease with which any student can contribute to the newspaper widens participation. Students become familiar with the network's function as a data organizer so that when other school projects—such as editing a video newscast—are started, students find it quite sensible to create a workplace for their scripts, plans, and edit lists.

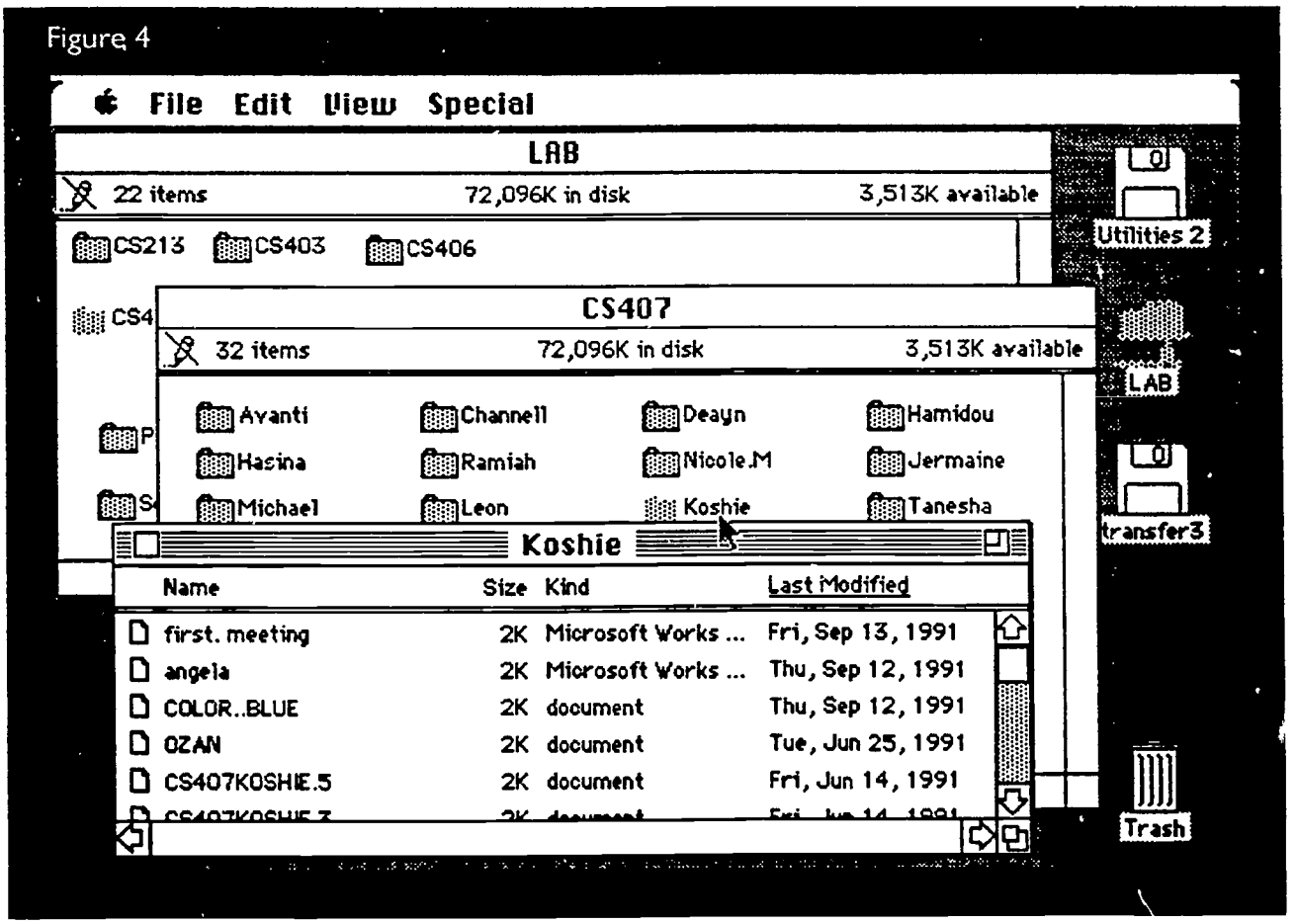
The workplaces provide continuity over time as well as location. Projects involving collecting weather data and data on seasonal change extend over many months. In some cases, projects may extend over years as new cohorts of students move through the school curriculum.

Students continue to develop their personal workplaces throughout their careers in the school. When Koshie returned to school as a sixth grader, all the work she had done as a fifth grader, including science reports, newspaper articles, and even a letter to a soldier in the Persian Gulf, were still in her workplace. Figure 4 shows a portion of her personal workplace during the first week of school. Notice that her writing and other data from fifth grade is still available to her, providing the student with a powerful sense of the continuity of her own work that transcends the boundaries between grades.

Many former Ralph Bunche students are returning to the after-school activity time from their new middle schools and are requesting space to work. Now the school has created a "Graduates" folder so that former students can retrieve files from their tenure at Ralph Bunche Computer School.

The use of tool software requires a greater initial investment in order to bring students up to speed with the technology than is required for more traditional

Figure 4



CAI programs, which present small tasks and simple interactions with the technology. However, the availability of the Earth Lab system to students over a period of years and the consistency of the available tools has made it increasingly easy for teachers to introduce long-term projects as part of their curriculum. In the first year of operation, the sixth grade class spent several months on fairly simple introductory projects designed to familiarize them with the word processing, database, and communication tools. Several years later, teachers are able to start immediately with substantial projects. The investment in developing capabilities to use a common set of computer tools helps create the sense of community of computer users. The common expectations show up powerfully in the students who come to expect that workplaces will be set up to manage collaborative work, and in teachers who are now able to use common knowledge of electronic mail to help students resolve emotional and personal conflicts, as did Stevon and Keesha in the vignette described earlier.

Principles for Design of a Project-based School

The system that is utilized at the Ralph Bunche School makes use of off-the-shelf technology, and is not optimized for the task of organizational change that is called for by the school's new structure and goals. As we begin a new cycle of technology design as part of the Copernicus project, we have the opportunity to start from scratch with some basic notions about school technology.

Students and teachers take increasing responsibility.

The fundamental notion is that students are expected to continuously take ever greater responsibility for their work. Traditional Integrated Learning Systems take exactly the opposite approach in centralizing all management and scheduling functions so they can be controlled by a system administrator. Seldom do teachers have any role in system management. In other systems designed for research or business environments, central control of the server systems is almost always assumed. We will want to distribute all management functions. Some system functions will be managed centrally, but teachers will have responsibility for such things as setting up work groups, creating new e-mail users, and providing software tools to individuals and work groups. We expect that many teachers will take on these responsibilities only after several years' experience with the system. Until that time, a system manager may have to provide administrative support.

Students will also be able to perform many of these functions. Young students, or students who are just starting with the system, may be provided with a ready-made environment. Over time, the expectation is that they will take over many of the management and scheduling functions. Learning to use the technology environment as a tool for carrying out their individual and group projects is a central part of learning to do school work.

Our current design for what we are calling the Galileo Manager calls for a database of people and groups, which contains a large amount of ancillary information that supports the work. The central administrator, the teachers, and the students will each have different levels of access to make modifications to the database. The goal will be to gradually increase each person's level of responsibility for modifying the computing environment.

We do not believe that a school environment in which students work on projects will be manageable unless students take a significant level of responsibility. The idea is not to create a more elaborate and detailed central management but to distribute the management to the students. That gradual change in responsibility is a major goal of the educational environment.

Workplaces are the unit of work and communication.

We are elaborating the concept of a workplace that was illustrated in the discussion of the file server used in the Ralph Bunche School. The workplaces will be the unit of communication as well as a workplace. In most e-mail systems, a "user" is the unit of communication. It is a user that sends and receives e-mail. In Galileo, workplaces will have that function. Each person will have a workplace, but so will groups of people who form work groups to tackle projects. That workplace will send and receive e-mail. The rationale for this is that very often classroom work groups will work together around a single computer and will be respon-

sible for creating a single product. The product (e.g., a newspaper) will be assembled in the workplace. Students will be able to submit articles to the workplace, and the editorial group, as a collaborative, will be responsible for responding to the incoming information.

The workplace will most often exist on a file server but in some cases may have its home on an individual machine (e.g., a notebook computer) carried around by the student. We do not expect that students will have individual machines for quite some years, but as that occurs, individual workplaces can reside there. Group workplaces will still have to be located on some common ground available to any member of the group or to the group when it begins to work on any computer. The Galileo system will provide access to these workplaces from any machine on the school LAN.

Connecting the local area network and wide area network.

Many projects will involve access to resources and other peers outside the school, as well as community access to the school. We note that a few schools are now beginning to take advantage of the packet-switched nature of the Internet to make network connections between their PCs and the network. As LANs become increasingly used for communication and as the wide area networks (WANs) of interest to schools are distributed via packet-switched networks, the two technologies begin to converge (Newman, Bernstein, & Reese, 1992).

There are two advantages arising from this convergence. First, with the LAN connected to the Internet, a student or teacher can sit down at any computer to call up a mail server or other remote resources. A second advantage of the convergence is the integration of the school community with widely distributed communities. With a mail server on the local school network, local and distant communications are supported by the same system from the students' and teachers' points of view. In these cases, we find local communications supporting local project groups that are accessing remote resources. Teachers use the local communications to coordinate their own work. The LAN is now a medium for supporting communication and sharing information among the local community, not just a means of access to the wide area resources.

Conclusions

The fundamental change that we believe accounts for the higher test scores at the Computer Mini-School was the greater sense of community and emotional belonging that became possible with the smaller class sizes and with the teachers' sense of ownership of the school and the collateral commitment to its success. The sense of community was supported by many other aspects of the Computer Mini-School including the common technology skills and the design of workspaces that allowed groups to work together. While technology was only very indirectly the cause of the improvements, we can ask how technology can be designed to directly support the restructuring and communication within a school community.

Scores on standardized tests are very powerful politically and can have a harmful effect on education as teachers and administrators invest time and resources to directly teach to the test, emphasizing the rote skills that are adequate for test taking. The experience at the Ralph Bunche School shows that test scores can be raised without subjugating instructional design to that task. We may even suspect that technology systems designed specifically to raise test scores through individualized instruction and a compartmentalized curriculum organization may be counterproductive insofar as they reduce the sense of community and common goals. Our current work attempts to give the community of teachers and students tools for working together.

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