THE QUARTERLY NEWSLETTER OF THE
LABORATORY OF COMPARATIVE HUMAN COGNITION
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Center for Human Information Processing
University of California, San Diego
July 1983, Volume 5, Number 3

Computers and Literacy: A Time for Tools

A Note on Transition:

Beginning with the next issue of the Newsletter, a new generation of scholars is taking over editorial responsibility. Drs. Jacquelyn Mitchell, Afro-American Studies Program, UC Davis, Luis C. Moll, Department of Communication and Teacher Education Program, UC San Diego, and Warren Simmons, Army Research Institute, have agreed to take over editorial chores. Technical assistance in production will be provided by Karen Fiegener, Alma Salcido, Peggy Bengel and myself. The new editors have several stimulating issues in the works, including a special issue on cognitive studies of work to be edited by Sylvia Scribner. They are eager to continue the Newsletter's ongoing commitment to fruitful interactions among scholars interested in the ways that human diversity can be utilized as a resource for social and scholarly progress.

Michael Cole

Introduction to This Issue

We are in the midst of a rapid evolution of a new communication medium, based on computers and computer networks. As this interactive medium develops, we are faced with the questions of what makes a person competent to use it. There is currently a debate about what constitutes "computer literacy." Of special concern is the issue of equity: will the existing inequities in society be reduced, maintained or increased; will the existing gender bias in computer use against females continue; will the media centralize or decentralize organizations and society.

These are large and complex issues. Each article in this issue of the Newsletter addresses some aspects of these questions within the domain of education. Some of the focus points are:

- What are the properties of the new computer-based media?
- What kinds of knowledge and skills will be required for individuals to perform competently with the new interactive media?
- What practical ways are there for acquiring the necessary competence?

Adults without print literacy skills are called "illiterate" and find it difficult to function in a print-oriented business world. Schools and colleges are now establishing courses of study with the title of "computer literacy," motivated by a concern that competency with the new media will be as important for adult functioning in the near future as print literacy is today.

Proposed definitions of computer literacy span the spectrum from *knowledge about computers and their impact on society* to *knowledge of how to write computer programs.* The debate over "knowing about" vs. "knowing how" draws the battle lines in a way similar to the varied definitions of being a "literate" person: at one extreme, being print literate requires knowing the "classic" works and being able to analyze their impact on society; at another extreme, it requires being able to write creatively.

In the classroom trenches, literacy takes on a much more mundane meaning. Being "print literate" means reading at grade level. "Computer literacy" is coming to mean skill at computer programming.

The current battle may in fact turn out to be futile. Because of the rapid rate of change in the technology of computing, just when the underlying philosophical issues finally become clear, a new generation of machines becomes available which presents such new capabilities that the previous discussion becomes irrelevant. This "philosophical obsolescence" has now overtaken the "knowing about/knowing how" distinction: there are now special purpose software tools that provide many different "entry points" for learning about interactive computer-based media.

What these tools provide are new media for communication and expression, each of which has its own requirements for competence. Thus we are now seeing the emergence of multiple computer literacies. These include different media for expressing text, for creating and editing graphics and animation, and for producing and modifying music.

A good example of such tools is the word processor, a special purpose program that allows the easy entry, deletion and manipulation of text. This tool allows both adults and children a new entry point to computer use that is very different from programming, drill and test, or arcade games.

Similar powers of revision are now available for graphics, animation and music, with special purpose "editors" providing entry points in each of these domains. These entry points are more meaningful for a person who has a special interest in the particular domain, since they allow even a novice to accomplish interesting tasks. So, a person with a special interest in music will find the editing capability provided by a computer music system intrinsically interesting, while a traditional programming introduction would create for this person a barrier of boredom.

Computer text editors have been designed as more powerful tools for producing text that was eventually printed on paper. We will soon see word processors that manipulate text uniquely suited for the special interactive properties of computer media, "interactive text." Similarly, special purpose tools in other domains are starting to take advantage of unique properties of the media. Even novices can now create music, pictures and animation that cannot be easily created with more conventional media.

As described in Cohen's paper, a study of exemplary uses of computers in San Diego shows the predominance of such "tool" use. Word processors, simulations, electronic networks, and electronic spread sheets were used in these classes. In most cases, these tools were developed for business or home use and only later adopted for educational use. "Electronic spread sheets" (VisiCalc, SuperCalc, etc.) are good examples of such powerful special purpose tools.

The development of such special purpose tools is the current cutting edge of educational software. We are starting to see "construction sets" and "toolkits," which are programs that allow even novices immediately to create interesting objects and events in a limited domain. One well-designed example, in a somewhat frivolous domain, is Bill Budge's Pinball Construction Set, which allows a complete novice to create his or her own video pinball game. The creator "picks" up components of a game (flippers, bumpers, spinners, etc.) and places them on a game board. Special purpose graphics and simulation tools are provided, including a magnifying mode and a "wiring diagram" mode. Games can have "bugs" (areas of the playing board where a ball can get trapped), and the creator then engages in "editing" the game (moving existing components or adding or removing components). In a very real sense, the creater of such a pinball game writes a computer program, but the process is significantly different from the conventional program writing process.

Each paper presented in this issue of the Newsletter addresses in a different way the issues of computer literacy. The paper by the CUSG group describing typical uses of computers in schools contrasts strongly with the report by Cohen of more exemplary uses. This report raises serious questions about equity in computer use, since the high achieving children in the schools observed engaged in a systematically different kind of activity from the low achieving children. Vargas-Adams describes an attempt to address these issues, a project to use computers for learning outside of schools in a low-income community center setting. Riel describes a very different approach for using computers for instruction, in her description of a project which engaged children having learning difficulties in activities using computers and computer networks to create a "functional environment" for writing and learning to write in school. Scollon describes some of the properties of such extended, decentralized computer-based communication networks.

A major theme of these papers is the diversity of computer use. There are now sufficiently powerful special purpose computer software tools that many different kinds of expertise are useful, many different kinds of "computer literacy." This finding is complemented by the recent observation that print literacy is not the functional monolith once presumed -- that there are many different kinds of print literacy (Cole & Scribner, 1974; Anderson & Stokes, in press).

A powerful implication of this diversity is that we consider multiple entry points to expertise with interactive media. The "special" status of programming is passing, with the development of powerful special purpose computer tools; the royal road becomes just another avenue in a complex of access roads. The inequities caused by limited-access roads can be dealt with to some extent by the development of multiple paths, each specially suited to a set of people ill-served by the previous routes. Arguments over what is *the* best avenue to expertise with these new interactive media may be overrun by the rapid construction of alternative byways, none as general as the current programming languages, but each better suited to the particular needs of a person.

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References

Anderson, A.B., & Stokes, S. (in press). Social and institutional influences on the development and practice of literacy. In F. Smith (Ed.), *Awakening to literacy.*

Cole, M., & Scribner, S. (1974). *Culture and thought: A psychological introduction.* New York: Wiley.

Exemplary Computer Use in Education*

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The educational system is faced with the challenge of integrating computers appropriately into its daily activities. Schools are under considerable pressure from parents, politicians, economic and academic leaders to introduce computers in the curriculum. While resources for purchasing computers are provided by grants and fund raising activities, the education system is left to provide the content (what should be learned about computers), the form (how to learn it) and the technical and academic support to enable educators to implement a curriculum that includes computers.

Several researchers have reported recent surveys on computer use in schools (Shavelson, 1981; CSOS, 1983; Tucker, 1983; CUSG, 1983). In the project described

*This research was supported by the Teacher Education and Computer Center, San Diego and Imperial Counties. Special thanks to Jerry Ackerman, Eva Bustos, Alison Cohen, Caroline Ferreri, Claude Gigoux, Qarin Van Brink and Kathleen Ward for conducting the observations and interviews. Also many thanks to James Levin, Randall Souviney, Margaret Riel and Bud Mehan for their many useful comments on earlier drafts of this paper.

here, we set out to find exemplary uses of computers in classrooms. We conducted an in-depth study of six exemplary classrooms in the San Diego County area, in order to identify the salient features and the critical aspects that contribute to exemplary computer use. Our intentions were to identify the range of characteristics likely to lead to successful use of computers in the classroom rather than describe normative cases.

The selection of exemplary sites could not based on an a priori predetermined model of how schools should use computers because of the lack of agreement on what the ideal model should be (Papert, 1980; Johnson, Anderson, Hansen & Klassen, 1980; Luehrmann, 1981; Anderson, Klassen & Johnson, 1981). It was also unclear whether there was an accepted, de facto, notion of an "ideal" computer use in the school system. Therefore we decided not to use any specific attribute of computer use in the schools, nor the similarity or dissimilarity among schools. Instead we decided to rely on the logic of anthropological research. Anthropologists seek the advice of local experts to point them to features of the environment considered by them to be most important. In our case we approached key educators, and asked them to identify local schools recognized as being exemplary users of computers in the classroom.

Potential sites were suggested to us by the resource teachers from the San Diego Teacher Education and Computer Center. The sites seemed well known to the group and there was clear agreement on the final selection. These teachers seemed comfortable in pointing out exemplary cases they had contacted within their region. We were struck, however, by the fact that each time these informants proposed a new school, they used a different set of criteria of excellence. One school was identified because it provided sound training to students for the job market; another for the motivation and dynamic nature of the teacher; a third for its widespread use of computers throughout the school and another for the level of programming skill achieved by students. We selected six of the 14 schools proposed by the resource teachers. The selection was based on geographical representation of the regions within the county and on the grade levels in the schools (2 elementary, 2 middle-school and 2 high-schools).

Four interviews and eight observations were carried out in each school during the Spring of 1983 by undergraduate students participating in a Computer Literacy course at UCSD. Each student received brief training in interview and observation methods and was assigned to one of the schools. A detailed observation schedule and interview guide was prepared. To provide a check on reliability, one additional student made independent observations in all six schools. A series of follow-up interviews of administrative personnel at each site was planned for the Summer of 1983. The following issues were addressed:

- Methods of introduction of computers to school
- Parental and community involvement
- Arrangement of computers in the classroom and the school
- Availability of computers and student access
- Hardware and software choices, problems and solutions
- Computer lessons, preparation and execution
- Integration of computers into curriculum
- Technical support required and sources available
- Impact of computers on students and teachers
- Projections for the near future

Descriptions of the Six Sites

Eucalyptus Elementary School services about 400 students in grades K-6. The students in the exemplary classroom were in grades 3, 4, and 5, and were selected by the teacher based on an application by parents. The school had one Apple II computer, housed in a movable cart, which is located most of the time in the back of the exemplary classroom. The students engaged in a range of activities, including word processing, real time communication with special education students in another school, data base management, graphics and animation, and programming in BASIC and LOGO. Students were scheduled to use the computer in pairs throughout the school day, while the other students were engaged in whole class lessons with the teacher. Occasionally the students rolled the computer to other classrooms to provide computing experience for the rest of the school.

The second classroom was at *Ebony Elementary School*, a district-wide "Computer Magnet." The teacher used twenty-three Apple II computers, interconnected in a "local network" in a "computer lab" setting. Other teachers in this school scheduled their classes into the computer lab once a week for thirty minutes. The computer teacher then conducted the lessons in the lab, focusing more than 90% of the time on LOGO programming. The rest of the time he used social science simulations and educational games. The teacher had the responsibility for providing computing experience to all of the K-6 students in the school.

Maple Secondary School was a district-wide Math, Science and Computer Magnet. The classroom observed serviced grades 7-9. The computer lab contained thirty Apple II computers, eight Pet computers, and thirty-two terminals to a main-frame computer. The teacher focused on BASIC programming, building on algebra as a prerequisite and leading to FORTRAN and Pascal programming at the senior high level. Seventh and eighth grade "magnet" students worked with the computers only during a two week period each semester. The ninth grade magnet students worked with the terminals during the whole school year, working in pairs for thirty-five minutes each day on BASIC programming.

Mahogany Middle School was the second middle school program observed. This classroom serviced all sixth grade students and elective BASIC courses for some seventh and eighth graders. The school used twelve VIC-20 computers (interconnected in a local network), and two Apple II computers, located in a computer lab setting. The two Apple computers were occasionally rolled to other classrooms for demonstrations. All sixth grade teachers scheduled their classes into the lab one hour a day for nine weeks, where they were taught by the computer teacher. The curriculum, prepared by the computer teacher, consisted of a series of short BASIC programming exercises. Students worked in pairs at their own pace.

At *Hickory High School*, the fifth site, the computer literacy program was developed by members of the Business Department faculty. The course consisted primarily of word processing, and BASIC programming with some data processing instruction. The business classroom used twenty-three TRS-80 Model III computers. The computer teacher's goal was to provide writing and other job entry skills to the largely minority students in this school. The teacher had five classes of about thirty juniors and seniors each day. The students used the word processing in this business course to write their English compositions and other writing for their classes.

Hemlock High School was the final site observed. This school was situated in a fairly affluent area. The computer lab had thirteen IBM Personal Computers and one Apple computer. The teacher taught three courses in computer literacy and also supervised periods of independent use. The curriculum focused on the use of a wide range of computer tools such as word processing, electronic spread-sheet programs, graphics and animation editors, simulations, data base systems, and some BASIC programming.

We found computer activities in these six schools that are among the least commonly found in other schools throughout the country. For example, four of the six schools observed (the elementary and the high schools) used their computers to teach word processing (among other things). According to the National Survey of School Uses of Microcomputers, word processing is used in only 3% of the elementary schools and 7% of the secondary (CSOS, 1983). Demonstrations, problem-solving using programming and recreational games were the other common uses in the schools we observed, while at the national level they were found regularly in only about one-fifth of the schools with microcomputers (CSOS, 1983). None of the exemplary schools we observed was engaged in systematic drill and practice use of computers, which occurs in 59% of primary and 31% of secondary schools in the country.

In general we found that these schools are responding to the computer challenge by encouraging diversity of use and content, relying on unconventional resources and support and settling for heterogeneous criteria of success.

Diversity of Use and Content

The most visible aspect of the use of computers in the six observed sites was the tremendous diversity of implementation and the implicit acceptance of this diversity as legitimate. The hardware and software available in schools, the accessibility of computers to students, the activities and content considered appropriate, the arrangement of computers in the classroom and the structure of lessons, all varied across the classrooms.

The diversity and incompatibility of hardware among schools in itself is not a new finding (Miller, 1983). Availability of funds, personal experience of teachers and constraints from the sources of funding are the obvious reasons used to account for the differences. The diverse attitudes of teachers towards the different hardware, on the other hand, are somewhat surprising. Some teachers intentionally expose their students to different computers and terminals while others avoid using more than one model. In two schools different models were used with the same students for different activities; in another school students were assigned to different models according to their skill: the most advanced students got access to the more expensive machines while the rest of the class used the less expensive machines. Since there were some technical problems with the less expensive machines (a network system for loading and saving programs was not working although it was supposed to be functional more than a year before) only the few students working with the expensive machines were able to save their programs and revise them later. The other students lost their programs when the machines were shut off at the end of the class.

We also found diversity in the quantity vs. computer-cost choice: some schools preferred fewer machines of a relatively expensive model while others preferred the opposite. This difference does not seem related to the absolute amount of funds available: One (affluent) school has 13 IBM Personal Computer while another (less affluent) school, with roughly the same number of students per class, has 20 TRS-80 model III machines. One elementary teacher (in a less affluent school) used funds to acquire a single Apple II while another school in a more affluent neighborhood preferred 12 VIC-20 which are about 1/10 as expensive as the Apple II.

Diversity in software used, activities allowed and "appropriate" topics parallels the diversity in hardware. There were big differences in the extent to which commercially available software was used as opposed to software provided by the district or created by the teachers and/or the students. In the classroom that used LOGO 90% of the time, students used specific procedures in LOGO, programmed by the teacher, in order to create artistic drawings. Once printed, the drawings were displayed on a special bulletin board. The other elementary teacher taught his 4th-5th grade students to use a commercial data-base program to print attendance lists for the school office. These students also regularly used a communication program to interact with handicapped students in another school using the computer and a telephone line.

In one of the middle schools the teacher allowed "arcade-type" games in class but only at the beginning of the year or after-school hours. In the other middle school the only commercial software available were drill and practice programs which the teacher disliked. Therefore the class used only programs developed by the teacher or the students. In the two high schools, the main activities were centered around applications of commercial software but there were differences because of budgetary constraints. In the more affluent school, students had access to a wide range of application software including graphics, music, word processing, data-bases and spreadsheet. In the other high school students worked primarily on word processing due to budget limitations, however, there were plans to buy data-base and spreadsheet software the following year.

Three of the schools stressed the importance of programming, while in the other three programming was not considered the necessary (and certainly not the best) entry point to computer use. One elementary teacher used LOGO, as described above, to teach programming procedures to children from kindergarten to sixth grade. The other elementary teacher used programming only as one of the topics of computer use. He used both BASIC and LOGO as examples of programming languages. He used another specialized program to create graphic designs. This teacher invited the undergraduate observer from our project to give a lesson on Pascal programming to the 4th graders and to discuss with them the differences among programming languages.

The two middle schools used BASIC as the programming language. In one of them the activities were traditionally structured: first an introductory course in algebra, then programming in BASIC, then in high-school students learn programming in FORTRAN. After completing these courses, students can take Pascal as an elective. The other middle-school teacher created his own booklet with problem solving exercises in BASIC dealing with arithmetic, language and graphic design. The two high schools didn't focus on programming as their main activity but instead stressed the use of software tools as preparation for the students' immediate future: college or the job market.

At present, diversity in computer-use in schools is the rule rather than the exception. All the teachers interviewed described having freedom of choice concerning the form and the content of computer classes. Most of the teachers knew their activities were different from classes at other schools but weren't bothered by the disparity. Moreover, everyone expressed interest in knowing more about other schools, looking for useful ideas to implement in their own classrooms. Even the secondary school with the most traditional approach (algebra, BASIC, FORTRAN) had just set up a new class with a different approach (more use of commercial software tools and much less programming).

Diversity in curriculum is not currently a general property of the conventional educational system. The movement is toward highly specified and centrally controlled curricular materials. Textbooks and district guides are generally specified using well defined goals and objectives. Often topics to be learned are carefully coordinated with specific teaching methodology. Standardized test are considered objective verdicts of success or failure. Curriculum innovators often refer to the "problem of program implementation," meaning the variability ("distortions") found among different sites when implementing a new program. This variability, often attributed to teachers, is usually considered a hindrance to the effect of the new program (Hall & Loucks, 1977; Fullan & Pomfret, 1977).

In the case of educational uses of computers, diversity seems to be instrumental. These innovative teachers are inventing effective ways to implement the use of computers in their instruction. Teachers currently are not told "here is a computer, a curriculum and a teaching method" but instead they are provided with computers and then queried about their use and effectiveness. If we take into account the rapidly changing technology of computers, it may well be that variability is the only way to generate the innovative approaches required to effectively use computers in education. More rigid strategy may be counter productive in the long run.

Unconventional Resources and Support

There was considerable reliance on unconventional and informal resources of support in all the schools observed. Teachers relied on friends or personal contacts to solve technical and management problems. Commercial computer magazines were consulted to identify high quality educational software. Teachers and principals approached businesses and research funding agencies to "adopt" or support school computer facilities.

Most of the teachers spent many unpaid hours at school either with students or preparing materials for computer classes. All the teachers stressed the importance of teacher motivation as a key factor in the effect of computer-use on learning in school. Older students and parents were mobilized to serve as aides in computer classes. The parental interest at two of the schools was so great that some who volunteered to assist in the computer classes had to be turned away. All the teachers spent extra time trying to keep their knowledge up to date, participating in conferences and computer-user groups, making professional presentations of their work and introducing other teachers to computers.

The reliance on unconventional resources for support is not a criticism of district inservice personnel. It would be more appropriate to say that:

- The help required is extensive and diverse: technical assistance (hardware), appropriate materials (software and documentation) and in-service training.
- Help is readily available from sources outside conventional district support facilities: it's easier and not unreasonable to ask a personal friend how to use a modem or interface a tape-recorder; it's easy and practical to take the faulty disk drive to the nearest computer store; a monthly computer magazine will always be more up to date with the latest developments on software than will a district publication; the newest and most attractive software is likely to be available on the store's shelves.
- Financial support may be easier to get outside the educational system. Even in the current state of economic uncertainty there is willingness on the part of community agencies, industry, parent associations and research institutions to support the purchase of computers for schools. These outside channels of support are attractive in times of fiscal austerity since they provide a feasible alternative to the shifting of resources within the school to provide funds for computer implementation (and thus avoid the potential resentment). Also, when teachers and administrators succeed in attracting this type of support, they gain status within the school and the community.

Heterogeneous Criteria of Success

The teachers were asked to assess what they regarded as their main achievements. One pointed to specific preparation for the job market, high enrollment for next year's courses and reduced absenteeism. Another indicated that due to experience with computers, students were excited by school and worked harder in all their classes. One high school teacher referred to his primary goal in the following manner:

> "The students are now comfortable with the computers, without the awe and intimidation felt by many. They are aware of computer capabilities, and may now be able to see a real world problem and know that a computer would be able to help to solve it . . . stressing the viewpoint of future computer users, not just programmers."

Others pointed to the programming capabilities of their students, the teachers' renewed interest in their work, the "Hawthorne effect" (improved performance resulting solely from the fact that a change, any change, in the environment was made) on teachers and students, remedial learning, mutual help among students and independent and self-paced learning.

Of the six teachers interviewed, only one expressed surprise at being chosen as an exemplary case. Most of these teachers have been exposed to a constant flow of visitors and to some extent "admirers." Teachers like these are often tapped for higher status positions within and outside the education system. Several have been the subject of newspaper articles and their classes have been filmed. A recent film on computer supported writing featuring four different classrooms (one of which was in our sample) has been produced by a local education authority and is being distributed throughout the State of California for inservice purposes. The teachers involved know that their work and achievements are valued by society.

In each case it seems reasonable to accept their heterogeneous achievements as valid. However, it is important to note that different and somewhat diffuse criteria are used to measure success. Improvement is neither measured on standardized tests, nor are systematic comparisons with control groups made in order to control for "placebo" or "Hawthorne" effects. We, as well as the teachers, parents and administrators, accept different and sometimes even opposing achievements as legitimate. Some students learn to program in LOGO, BASIC or Pascal while other learn to use software tools like word processors, spreadsheets and data bases. It may be that the only discernible effect of computer-use is on student general motivation to school or in the social organization of learning such as improved teacher-student relations, more independent work or mutual help among students. This lenient approach to evaluating success is not the usual case in schools for other subjects where requirements are often more constrained, well specified and systematically assessed.

Conclusions

What can we learn from this observations? Schools are faced with the challenge of effectively integrating computers into the learning process. These exemplary cases are responding in a manner of "evolution by natural selection:" developing variation, facilitating replication and striving for survival in a technologically dynamic environment.

In the schools observed, there was a clear tendency for teachers to devise their own program of study involving computers, programs that were closely related to the teachers' own skills and personal interests. A teacher's personal interest is extremely important since the teacher will be committing many unpaid hours to keeping up to date on hardware and software developments, designing curriculum and support material, and sharing the expertise with colleagues. The specific form of computer use in each school will also depend on anticipated employment requirements, parental expectations, funding constraints and the availability of technical support. Accordingly, each school will set up their own norms of achievement, which will not necessarily be consistent with other schools.

Successful programs survive by being selected for implementation by other teachers and by being adapted to new technologies. Newcomers to the implementation of computers in education search for attractive uses to adopt in their own classrooms. Since they have some degree of freedom they become the key for the survival of the best forms of use. Thus computer "buff" teachers have become the critical "grassroots" factor in adapting the use of computers in schools to current technological developments.

The continuous development in computer technology and the diversity of equipment available in the schools are natural barriers which these successful implementations have to overcome. Because of the technical incompatibility of the various computer models and the relatively short life span of the machines, computer literacy should not be limited to hardware with very specific characteristics. Teachers' awareness of this problem encourages them to keep developing and broadening their expertise.

If the implementation of computers in education followed the traditional top-down hierarchical approach, it could not keep abreast of the rapid technological changes and might become overly constrained in its application. Using a traditional approach to curriculum development, district level personnel would arrange for systematic evaluation in order to decide which specific type of use to recommend for various groups of students. They would next design curriculum and supporting teaching materials, arrange inservice and proceed with the introduction into the schools. The amount of time for changes of this type to be introduced would be too long to take full advantage of current technology. By the time the chosen approach was installed in the schools, it would likely be outdated.

The current diversity of accepted implementations, the less rigorous definition of what counts as achievement and the availability of unconventional support and resources, together form a protected environment in which teachers are able to experiment with the use of computers in their work, create new forms of use and keep up with the rapid technological change. The immediate effect on classroom instruction seems to be an increased involvement on the part of teachers and more enthusiasm from the students.

We also found that the activities in these schools are among the least common found in other schools throughout the country. If we consider the exemplary status and the visibility that these schools enjoy, our findings may point to future trends in computer use in classrooms: more word processing and other computer supported tools, a decrease in drill and practice and a reduced emphasis on programming as the primary skill associated with computer literacy.

References

Anderson, R. E., Klassen, D. L., & Johnson, D. C. (1981, December). In defense of a comprehensive view of computer literacy: A reply to Luehrmann. *Mathematics Teacher, 74*, 687-690.

Center for Social Organization of Schools (CSOS). (1983, April and June). *School uses of microcomputers: Reports from a national survey* (Issues 1 and 2). Baltimore, MD: The John Hopkins University, CSOS.

Computer Use Study Group (CUSG). (1983). Computers in schools: Stratifier or equalizer? *The Newsletter of the Laboratory of Comparative Human Cognition.* This issue.

Fullan, M., & Pomfret, A. (1977). Research on curriculum and instruction implementation. *Review of Educational Research, 47*(2), 335-397.

Hall, G. E., & Loucks, S. F. (1977, Summer). A developmental model for determining whether the treatment is actually implemented. *American Educational Research Journal, 14*(3), 263-276.
Johnson, D. C., Anderson, R. E., Hansen, T. P., & Klassen, D. L. (1980, February). Computer literacy: What is it? *Mathematics Teacher, 73,* 91-96.
Luehrmann, A. (1981, December). Computer literacy: What should it be? *Mathematics Teacher, 74,* 680-686.
Miller, J. J. (1983, April). Microcomputer use in San Diego/Imperial County schools. *Planning, Research and Evaluation.* San Diego, CA: San Diego Department of Education.
Papert S. (1980). *Mindstorms, children, computers, and powerful ideas.* New York: Basic Books, Inc.
Shavelson, R. J. (1981, December). *Teacher knowledge and computer use* (Research Prop.). The Rand Corporation.
Tucker, M. S. (1983, April 27). Solving achievement problems in bits and bytes. *Education Week,* 19-20.

Computers in Schools: Stratifier or Equalizer?

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Computers are being promoted as the educational tool of the eighties. Almost daily, we are being informed of the dangers of a computer illiterate society. With almost blind faith, schools are taking on the responsibility of supplying computer education. As history has shown us, innovations in social systems have unforseen consequences for those systems (Sarason, 1982). These effects can be both positive and negative. But, in most cases, and most importantly, they have been unanticipated. As schools acquire and use microcomputers for educational purposes, the following are some of the questions that concern us:

(1) will students from different strata of society obtain equal access to computers?
(2) will students from different strata of society be taught similar or different uses of computers?
(3) will computers enter schools briefly, and then, like previous forms of educational technology, be stored in the closet because teachers fail to find ways to use them to accomplish their educational goals?

In short, we are interested in trying to determine whether computers will be tools which facilitate equality among different social groups or whether they will be tools which further stratify groups within society.

We know something about the *numbers* of computers that are in U.S. schools. For example, a national study of educational technology in 1983 reported that 53% of all schools in the U.S. had at least one computer as of January 1983 (Center for the Organization of Schools, 1983). The pace at which computers are being acquired by schools is so rapid that a 1974 survey of educational technology did not even have an entry for microcomputers in its survey instrument (Kincaid et al., 1974). The State of California conducted its own survey in 1982; that report indicated that 29% of the schools in California have at least one computer or terminal. Miller (1983) reports that 83% of 402 schools in San Diego and Imperial Counties have at least one microcomputer.

We know less about the *distribution* and *use* of computers in schools than we know about the *numbers* of computers in schools. With few exceptions, e.g., Sheingold (1981), studies of computers in schools do not report whether students have equal or differential access to computers. Sheingold (1981) found that computers were being used most often in resource rooms and hallways, and seldom in classrooms. She speculates that the placement of computers in hallways and resource rooms may have been the result of a commitment to achieve equity because all students could pass through these computer centers. As soon as computers began moving out of hallways and into math and business classes, differential access became apparent. Only those students who elected or were selected for these programs received instruction on computers. She also reported that many more boys than girls use computers at all grade levels, but she did not indicate any ethnic group or social class differences in computer use.

THE APPROACH OF THIS STUDY

In order to get some sense of the relationship between the numbers of computers in schools and students' access to computers, we arranged to observe computers being used for educational purposes in 21 schools in five school districts in two Southern California counties in January, February, and March of 1983. The schools ranged in student population and computers available for educational purposes. The relevant information about the schools and their computers is summarized in Table 1.

Table 1

School or District	*Number of Students*	*Number of Schools*	*Number of Computers*
Sierra	700	2 elementary	22
Piquin	4781	8 elementary	26
Cayenne	3692	9 elementary & secondary	183
Chipotle School	625	1 secondary	57
Jalapeno School	674	1 elementary	5
Total	10,472	21	293

Students were the primary users of computers. In all the schools we observed, students had priority over teachers' record keeping and administrative uses of computers. This observation contrasts sharply with an NSF sponsored survey of secondary schools conducted in 1970, which showed that computers were used for

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instructional purposes in only 13% of secondary schools (Darby et al., 1970).

We did not select these schools according to a formal sampling procedure; we capitalized on personal contacts to facilitate access. Since our schools were not sampled randomly, care must be taken when generalizing from the information that we obtained.

Likewise, we did not randomly sample the people to be interviewed. If there is a formal term to characterize our approach to interviewing, it would be called the "snowball technique." We started with the teacher, resource person, or whomever we could find who knew about computers in the school. When an interview was completed, we asked that person for the name of others involved in computer use, and interviewed them. We continued this procedure until there was no one left to interview.

Our observation schedule was much easier, for, as we will explain below, computer use in most of the schools we studied was centralized in a media or resource center. The centralization of computer activity facilitated our observations. Our observations and interviews were guided by a common set of orienting questions about the distribution and use of computers in schools. (The guiding questions for observation and interview are available upon request.) We often found that different educators in the same district had inconsistent answers to our questions. For example, one educator might indicate that the rationale for using computers was "to raise test scores," while another might suggest "enrichment" as the reason for investing in computers. Before reconciling these different views, we treated these responses as indicating the novelty of computers in education which create discrepancies in the reasons cited for their use.

THE STRATIFYING AND EQUALIZING EFFECTS OF COMPUTER USE

In order to get some sense of the stratifying or equalizing effects of computer use in schools, we examined the relationship between the characteristics of schools and the students they educate and the policies and practices of computer use. We found a very strong relationship between (1) the source of funding for computer acquisition, (2) the type of students who are educated using computers, (3) the type of instruction students are exposed to and (4) the rationale for computer use in the five districts that we studied.

The Sponsorship for the Acquisition of Computers and Students' Access to Computers. The acquisition of computers has been sponsored by many agencies. The State of California and the Federal government were the most prevalent source of funds. Money available for the education of "gifted and talented" youngsters (GATE), "economically and culturally disadvantaged" students (Chapter I), school improvement programs (SIP), and the desegregation effort purchased 93% of the computers in these districts. Private funding, most notably donations from PTA groups, accounted for 5% of the computers acquired. PTA groups sold land, sponsored "jogathons," and collected aluminum cans in order to acquire computers. One enterprising teacher had a local computer store "sponsor" her classroom in exchange for the loan of microcomputers.

Interestingly, no "line item" budgetary funds were used by these districts to acquire computers, which contrasts with Sheingold's (1981) findings. The Piquin District systematically used principals' discretionary funds to acquire computers; this was the only district that spent its regular money on computers. However, the Sierra district now has a $20,000 "line item" in its annual budget for software acquisition and maintenance.

There is a relationship between the source of funds used for computer acquisition and the students who have access to these computers. Chapter I, School Improvement Program, and desegregation funds are used primarily to educate ethnic minority and lower class students on computers, while GATE and private funds are used primarily to educate middle and upper middle class students.

Computer Location and Student Access

There are 3 major arrangements for computer use in the districts that we studied. Computers are either placed in central labs, or they are assigned to special programs such as GATE or Follow Through, or they rotate between special programs and classrooms. We found only one classroom in which a computer was assigned on a regular basis.

The modal location of computers is in math, media, or computer labs. Nine of the 21 schools we surveyed placed their computers in a central facility, and rotated students through the lab. We could not determine whether this arrangement represented a planned curricular choice designed to achieve equity (Sheingold, 1981), was a security measure or a pragmatic response to the fact that there were not enough computers to assign to each classroom.

Instead of having students rotate through a central lab, five of the schools in two of the districts rotate 10 of their computers through classrooms on a regular basis. This "computers on wheels" arrangement gives students exposure to computers on the average of once every two weeks. Students' access to computers is increased in one school, because a teacher has volunteered to run a "computer club" after school for all students who are interested.

Five of the eight schools in the Piquin and Cayenne Districts assign their computers to more than one group of students. Before school starts in the morning, computers are assigned to GATE teachers for use with high achieving students. The GATE students voluntarily come one hour 40 minutes before school to participate in this program. Then later in the day, these computers are placed on carts and go to other classrooms.

In sum, 89% of the computers in these five districts are assigned a single use -- in labs or special classrooms, while 9% of the computers are assigned a multiple use -- either rotating between classrooms or rotating between GATE classrooms and regular classrooms. The remaining 2% of the computers were still in storage at the time of our study. We find the rotational arrangement interesting for two reasons. One, it shows a creative use of funding; funds originally available for a special group of students are being spread to students in "regular" programs. Two, it indicates that "special" students are being given greater access to this new technology than "average" students.

The location of computers in schools dictates their use and students' access to them. In the Sierra District and Jalapeño School, which have central computer labs, all students kindergarten through sixth grade have access to computers. In the Sierra district all students visit the lab on the average of once every two weeks with their reading groups. One child works at a computer for about 40 minutes at a time, which produces an average of 20 minutes per week of computer use. In the Jalapeno School all students rotate through the computer center once a week at half hour intervals.

The practice of this equal access policy was not as prevalent in the Chipotle School, established as a "magnet" to attract white families to an inner city ethnic neighborhood. The stated policy of the Chipotle School is similar to that in the Sierra and Jalapeño Districts: to give all students equal access to computers for instructional purposes. However, we observed disparities between stated policy and observed practice which point to the potentially stratifying effects of computer use.

The Chipotle school functioned almost as two separate schools. It provided self-paced computer classes for each of its 6 grade levels and supporting activities in math and science. Ethnic minority students from the local neighborhood who were not a part of the magnet program did not have computer education as part of their curriculum. Instead, they participated in an academic program which stressed basic skills taught in a regimented fashion with workbooks.

Ethnic minority students who came from the local neighborhood only had contact with computers in Math and English Skills Labs. The Skills Labs are centers stressing basic skills that are tutored by a specialist and reviewed on the computer using drill and practice methods. Most of the white students in the magnet had access to the computers for programming or problem solving activities.

We observed a similar practice in the magnet high school of the Cayenne School District. While all students had access to the computer in this school, instruction was stratified by ability groups. Programming courses, for example, were arranged in four levels. All students in the school were given the first, basic year of instruction. Only high achievers (which include all the white ethnic transfers) were given access to higher level and advanced programming. Low achieving students, which include all the local ethnic students, were sorted into vocationally based instruction after the first year.

Likewise, in the Piquin district which has a "multiple use" policy, there are differences in student access to the computers. In the schools where computers are assigned exclusively to GATE classrooms, each GATE student averages 60-80 minutes per week on the computer, and other students have no access to the computers at all. In the schools that rotate computers between GATE classrooms and other classrooms, each GATE student has 40 minutes per week on the computer, and other students have 20 minutes per week on the computer. But, not all students in regular education programs gain access to the computer under this arrangement. While all teachers who ask for computers can get them, not all teachers do ask. Those teachers who participate in rotating computer activities have computers in their classrooms on the average of two weeks a year. Thus, where computers are being used in regular (i.e., not GATE, Special Education, or Chapter I) classrooms, it is because teachers are are highly motivated or highly knowledgeable. Hence, the policy of placing computers on wheels seems to increase the number of students who have access to computers. However, the amount of time available to any one student is less under this arrangement.

We also found that boys and girls had differential access to computers, especially in secondary schools. In elementary schools with central lab facilities, boys and girls had equal access. However, observation of voluntary time on computers (e.g., at lunch and recess) revealed more boys than girls using computers in their spare time. The stratification of boys and girls on computers coincides with the curricular divisions of boys and girls in math and science subjects.

Instructional Applications of Computers

Computers are being used in conjunction with a wide range of subjects in elementary and secondary schools, including math, English (notably vocabulary, spelling and grammar), science and music. Students are also being taught how to program computers and how to use the computer to practice problem solving and test hypotheses.

The most prevalent instructional applications of computers in the 21 schools were basic skills instruction and computer literacy, priorities which are consistent with CSOS' (1983) national survey of computer use. In basic skills instruction, students were given drill and practice on material which supported their regular classroom activities. In computer literacy activities, students were given instruction in computer programming, mostly in BASIC.

Ethnic minority and lower class students receive a different kind of instruction on computers than their middle class and ethnic majority contemporaries. While middle class white students, especially those who are in GATE programs, receive instruction which encourages learner initiation (e.g., programming, problem solving), lower class and ethnic minority students, especially those in Title I programs and magnet programs, receive instruction which maintains the control of learning in the machine, (e.g., drill and practice repetition of work first taught in conventional curricula).

The Rationale for Computer Use

We asked school officials why they were introducing computers into the school curriculum. Educators' answers included: "we want kids to feel comfortable with computers," "we want students to learn programming . . . it is an important skill," " students can gain control of the medium by learning to program it," "computers can help teach academic subjects," "computer awareness," " we need to raise CTBS scores . . . we think computers can help us do that."

Educators' reasons for acquiring and using computers are not randomly distributed. They line up with the sponsorship of computers and the students who use them (see Figure 1). Computers are used to "raise the test scores" of lower class students (who receive drill and practice instruction on computers acquired through Chapter I and desegregation funds). Computers are used to "enrich the curriculum," and to teach programming and present logical problems to middle class students (who receive learner initiated instruction on computers purchased through GATE or private funds).

CONCLUSIONS

The following are the major conclusions from our study of computer use in five school districts in Southern California. Because we focused on a small number of school districts in a circumscribed geographical area, care must be taken when generalizing from our findings.

The most prevalent instructional application of computer use was for basic skill instruction and computer literacy. When computers were used for basic skills instruction, students were given drill and practice on material which supported instruction they received in their classrooms. When students were exposed to computer literacy, they were taught how to program computers, mostly in BASIC. Computers were used for writing, music, and art far less often than they were used for CAI and programming. Like Tucker (1983), we are surprised at this order of priority. First, the full power and range of microcomputers are not being exploited when microcomputers are used for basic skills instruction and programming. There is little evidence to suggest that microcomputers can deliver basic skill instruction better than conventional techniques; and their utility diminishes when their high cost is taken into consideration (Tucker, 1983). Second, the use of computers for basic skill instruction and programming does not match the needs of the world of work, where microcomputers are used for text editing, spread sheet analysis, and data systems management. As school districts become more familiar with the strengths and limitations of microcomputers, we hope that educators establish the uses of microcomputers based on educational objectives and not simply preliminary perceptions of what the computer can do.

Access to computers and computer use was differentially distributed. Ethnic minority and lower class students receive a different kind of instruction on computers than their middle class and ethnic majority contemporaries. While white middle class students, especially those who are in GATE programs, receive instruction which encourages learner initiation (programming and problem solving), lower class and ethnic minority students, especially those in Title I programs or magnet schools receive instruction which maintains control of learning in the machine (computer aided drill and practice). The tracking of students from different socioeconomic backgrounds through different computer based curricula stratifies students' access to information technology. Differential access represents one of the ways in which the microcomputer can be used as a tool to contribute further to the stratification of our society. If only a few people learn to control computers, then we will have a system of stratification based on technological capital that will make the one based on economic and cultural capital look pale by comparison.

The most prevalent placement of computers was in central computer labs. This configuration either represents a change in school policy since Sheingold's (1981) study, or suggests that we do not have a representative sample in our study. Microcomputers were seldom found in classrooms. When teachers did integrate computers into their classrooms, the computers had been at the school site for a number of years, and the teachers were highly motivated and/or were very knowledgeable about computers and their use. Furthermore, these "computer buffs" (Sheingold, 1981) had links to local computer clubs, professional computer using organizations, or to a university.

These school districts spent very little of their own money to acquire computers, which is not the prevailing national norm. This finding may be unique to the districts we studied, or it may be a function of Proposition 13, the tax initiative which reduced the money available to school districts in California. Although these school districts relied on state and federal money which was designated for certain students to acquire computers, observation of computer use through time shows that computers are not limited to the groups for which they were acquired originally. After a year or two, computers acquired for GATE students begin appearing in regular classrooms, a finding that both shows the diffusion of computer use, and the ability of school districts to find adaptive solutions to pressing educational and fiscal problems.

Will computers last in schools? Or, like other highly promoted educational innovations such as educational television or the new math, will they have a short lived existence? In evaluating the life expectancy of computers in schools, it is important to keep in mind that the impetus for their acquisition comes from sources which are external to the school. Computer manufacturers, computer using businesses, and parents, fearful that their children will not develop skills needed in a technologically dominated marketplace, pressure schools to teach students about computers. These pressures highlight the relationship between schooling and the world of work. Schools' reaction to this relationship may very well determine whether computers *stay in* schools. If schools adapt their curricula to meet, indeed even anticipate the uses of computers in the world of work, then we can expect computers to be a viable part of schooling. Their viability will be increased to the extent that their impact on all aspects of the social system of the school is anticipated (Sarason, 1982). If, however, schools continue to use computers as the majority of them are -- as fancy teaching machines for basic skill instruction through drill and practice -- then we can expect computers to recede in importance in schools. People will learn the more compelling use of computers, e.g., text editing, spread sheet analysis, data management, music and art from sources outside the schools. If people turn away from schools to learn about information technology, then this social movement will have a profound impact on the structure and function of school as we know it (Illich, 1970).

References

Center for the Organization of Schools (CSOS). (1983, April and June). *School uses of microcomputers: Reports from a national survey* (Issues 1 and 2). Baltimore, MD: The John Hopkins University, CSOS.

Darby, C.A. Jr., Korotkin, A.L., & Romasho, T. (1970, October). *Survey of computing activities in secondary schools* (Final Rep. to the National Science Foundation). Washington, DC: American Institute for Research.

Illich, I. (1970). *Deschooling society.* New York: Harper & Row.

Kincaid, H.V., McEachren, N.B., & McKinney, D. (1974). *Technology in public education and secondary education.* Menlo Park, CA: SRI.

Miller, J.J. (1983). *Microcomputer use in San Diego/Imperial/County school districts.* San Diego, CA: San Diego County Department of Education.

Sarason, S. (1982). *The culture of the school and the problem of change.* Boston: Allyn & Bacon.
Sheingold, K. (1981, February, 19). *Issues related to the implementation of computer technology in schools: A cross-sectional study* (Preliminary Report to the National Institute of Education Conference on Issues Related to the Implementation of Computer Technology in Schools). Washington, DC: National Institute of Education.

The CEDEN Community Computer Education Program: An Experiment in Educational Equity

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Introduction

Computer education is emerging into an imperfect world: the social, economic, educational and ethnic inequities manifest in certain sectors of United States society are bound to have an impact on the relative accessibility and quality of computer education. Concern has begun to be expressed regarding various inequities perceived to date. Low-cost micro-computers are mainly found at present in wealthier schools or school districts, private schools and middle to upper income homes. As a result, some observers suggest that the computer may ultimately serve as an instrument for the greater alienation and subordination of low-income families and ethnic minorities. Children from such homes may fall even further behind their middle-income peers who have access to computers, in terms of their motivation to learn and school achievement.

Computer education can be used flexibly in either formal or informal settings. It may be hypothesized that this flexibility will enable community-level computer education programs to provide high-quality educational opportunities to many low-income parents and children, and thereby help to overcome some aspects of current educational inequities. Culturally-appropriate community programs may well provide a "cultural bridge" between the home and the schools, encourage parents to take an active role in motivating and teaching their children and improve children's learning abilities and school achievement.

[1]CEDEN, founded in 1979, has designed and implemented complementary activities with the community including the Parent-Child Program, a nationally recognized parent and early childhood education program for preventing and reversing developmental delays in children 0 to 3 years of age.

CEDEN, the Center for the Development of Non-Formal Education,[1] a non-profit educational research and development center located in the Mexican-American barrio of Austin, Texas, has designed a community-level Computer Education Program, often called, "The Computer House." This program, its history, objectives, activities, participants, and evaluation results will be described in this paper.

History of the Program

The CEDEN Computer Education Program (CEP) is a direct outgrowth of early computer education experiments conducted by the Stanford Research Institute (SRI) in the late 1960's and early 1970's, which showed that young children could learn to program and become highly motivated to learn through use of the computer.[2] It was also influenced by experiences of the Cenide Computer Education Program in Spain (1969 to 1972) financed by UNESCO/UNDP and The World Bank, and guided by SRI. This program demonstrated that children from low-income homes, often with illiterate parents, could similarly benefit from computer education and that such parents could become very interested in computer education and their children's learning.[3]

Subsequently, the author left UNESCO and was only tangentially involved with computer education, but during six years, developed several non-formal education[4] research and development programs in Latin America. These experiences assisted with the design, implementation and evaluation of the current bilingual Computer Education Program. In 1981, CEDEN requested a donation of micro-computers from the Atari Institute for Educational Action Research. During 1982, CEDEN staff members experimented with a home-based approach, but decided to change to a center-based format, in order to achieve open and continuous access to computer education on the part of more low-income families.

The CEP completed its first four-month program period in May, 1983.

Program Objectives

The CEDEN Computer Education Program had a discrete set of objectives pertaining to the program as a whole, participating children and parents, as well as relationships with the schools:

OBJECTIVES

Program Level

- To design, implement and evaluate a community-level, bilingual computer education program for low-income Mexican-American families using parents and community members as teachers.
- To develop a comprehensive program model using complete program development processes, which potentially could be replicated in other community settings.

[2]Dean Brown, et al., "A Pilot Experiment in Educational Technology Using Computers in the Affective Domain," Stanford Research Institute, Menlo Park, 1969.

[3]Dean Brown, unpublished manuscript, 1972.

[4]Non-formal education may be defined as structured, yet flexible, out-of-school educational programs which seek to complement and supplement formal education.

The Children

- To motivate the children, 3 to 13 years of age, to want to learn and to continue learning by means of computer-related and auxiliary activities.
- To assist the children to learn new concepts and skills, reinforce others, and gain a desire to learn about computers.
- To obtain the children's assessment of "The Computer House," their suggestions for its improvement and interests in future learning.

The Parents

- To enroll, motivate, and guide low-income, Mexican-American parents to teach their children.
- To motivate the parents to acquaint themselves with computers and to use the computers for learning.
- To obtain their assessment of "The Computer House," suggestions for its improvement and interests in future learning.

The Schools

- To obtain the assistance of the schools in order to assess the children's problems, needs, and achievement.
- To assist the schools by providing learning opportunities focused on improving the children's motivation to learn and by improving their knowledge and skills in areas of prior low achievement.
- To improve parental involvement in schools, especially with regard to homework.

This set of ambitious goals for a four-month program was to be met by means of the following activities.

Program Activities

The Computer House, Located in the heart of the Mexican-American barrio of Austin Texas, is a small single-family dwelling typical of the neighborhood. The CEDEN staff designed the main computer/living room area to resemble a typical home setting: blue walls, lace curtains, Mexican-American cultural symbols, plus the usual decorations provided for young children. The goal was to provide a culturally appropriate and stimulating atmosphere for program families.[5]

The participants collected a series of teaching and learning resources in the Computer House: learning toys for all age groups; an arts and crafts table with ample supplies and opportunities to create whatever interested the adult or the child; a reading corner with books in English and Spanish for preschool and elementary school-age children; and the computer area with Atari 800's and 400's plus an extensive library of programs. Thus, at any point a parent or child could choose an activity area and explore its contents and possibilities.

At the outset of the program, all parents and children were assessed with regard to their interests and skills or knowledge levels in particular domains. We emphasized the areas in which they were most motivated and guided them through specific pre-computer activities, then to particular computer programs and finally provided post-computer reinforcement and creative activities. The participants' interests then changed dramatically as they became more involved in exploring new areas and motivated to learn and willing to risk tackling topics formerly deemed to be too difficult (e.g., mathematics, English, etc.). In essence, we emphasized the affective domain first, then exploration, problem-solving, and decisionmaking and finally the cognitive domain.

A variety of teaching methods were used. The main ones were demonstration and practice, as well as free exploration with a modicum of guidance. The latter was emphasized throughout in order to make the participants feel free to take risks and explore computers, learning topics and the auxiliary resources in the room. Traditional classroom teaching methods of lectures and lengthy explanations were not used. With regard to interpersonal interaction, we fostered peer teaching between children, as well as children guiding adults. Parents were shown how to teach and reinforce their children in positive and supportive ways, and jointly they designed take-home activities which extended their interaction and learning sessions to their homes. More research needs to be conducted on the types and amounts of these interactions in the future.

The CEDEN computer library contains over 100 programs for the Atari, most of them commercially available, although some are ones developed by program staff or friends of CEDEN. They cover various areas of pre-school education and school-based education as well as non-school topics: mathematics, language arts (English and Spanish), science, simulations, story writing, poetry writing, art, music, geography, video games, and adult-level programs of various types. We tended to emphasize educational games which motivated the participants and yet reinforced their abilities, creative programs of all sorts and simulations for promoting discovery learning experiences. As a result, children and adults who were previously disaffected from specific topics became delighted to learn them. Often a parent, weak in a particular area, would continue to play an educational game which his or her child had abandoned for another activity. Many times these were parents who had feared any type of formal learning experience.

The parents and children spent only one hour a week in the program for a total of 18 weeks. They were not charged a fee, due to the extreme poverty of the families in the neighborhood. Our major logistical problem was transportation since most of the families were too poor to be able to afford a car.

The staff was composed of the center director, Emily Vargas Adams, the project co-director media specialist, Patricia Platt and the computer teacher, Mary Donley. The Director designed the program, prepared program papers, trained the computer teacher, worked with the children and parents, and designed and conducted the evaluation component. The CEDEN's Media Specialist helped to prepare the program, trained the computer teacher, worked with families and designed, directed and produced a videotape on the project, a copy of which may be obtained from CEDEN. The computer teacher, an elementary school teacher, is a barrio mother, and a participant in the Parent-Child Program. A gifted bilingual teacher and educational materials specialist, she worked sensitively with the parents and children, using the center's philosophy, methods and

[5]The Program is more fully described in: Emily Vargas Adams, "CEDEN Computer Education Program: A Philosophical Program Statement," unpublished manuscript, Austin, Texas, January, 1983.

resources to advantage.

The program was relatively difficult to evaluate, given the variety of its goals and the complexity of the project. The evaluation had a quasi experimental, pre/post design and covered basic monitoring of attendance, socioeconomic variables on program families, parental entry/exit attitudes, interests and motivation, the children's entry/exit school record, abilities, needs, interests and motivation, and the computer teacher's plans, observations and evaluation comments. Internal program evaluation included a continuous process of self and group assessment.

The Participants

A total of 39 persons were enrolled in the program, with 5 other infants brought along. In all, 17 families were represented, with 10 adults (9 mothers, 1 couple) and 29 children enrolled. Of the children, 13 were preschool age, from 2 to 5 years, and 16 were school age, from 6 to 13 years. The average age was 6.7 years and the average family size in attendance was 2.35 members. At first, we planned to work only with children 3 years and older, but we found that 2 year olds could also benefit from computer programs for older pre-schoolers.

With regard to family status, 8 were nuclear families, 5 were headed by single mothers and 2 children were orphans. Of the 17 families, 11 were at or below the poverty level. Over half of the mothers had not finished high school. This situation reflects the general tendency in the barrio for early drop out and low educational attainment.

A total of 9 parents attended the computer sessions regularly, for whom we have entry and exit interviews. Although this number is small and represents a case study level of analysis, we believe that the results are of interest and reflect general tendencies found in our research on the parents who participate in the larger CEDEN Parent-Child Program.

Upon entry, the parents were asked about their level of satisfaction with the schools that their children attended. Most parents (66.7%) expressed dissatisfaction with the schools, and those at or below poverty did so at slightly higher rate. The upwardly mobile families who are critical of the schools are a particularly interesting group in the barrio.

We asked about the parents' previous level of involvement in the schools. Seventy-five percent of the parents below the poverty level reported no involvement in their children's schools while only 20 percent of those parents above the poverty level reported no involvement.

In our sample, low-income families clearly tended to avoid interaction with the schools, and this is also the overall tendency in the barrio as a whole. Upwardly aspiring families seemed to be making more of an attempt to work with the schools. Income level also had a direct impact upon the level of parental aspirations for their children. "High" aspirations were defined as professional level work and "moderate to low" as blue collar or lower level white collar work. Families with incomes above poverty level had higher aspirations for the children than below poverty families. Particularly dramatic was our finding that nearly 80 percent of the Mexican-American parents, irrespective of income level, *expected* their children to have problems in school. Over 60 percent indicated they felt their children were poorly served for their experience at school. Interviews with the children's teachers confirmed this pattern of problems in school. Given the types of problems, it is no surprise that the majority of the children reported that they were significantly disaffected from school.

It is within this complex and difficult situation low achievement, problems in school and alienation from formal education--that the Computer Education Program attempted to achieve its ambitious goals.

The Results

The Program Level. The program was fully implemented from January 20 to May 26, 1983, according to its design and plans. A greater number of low-income than lower-middle income families were attracted to the program, and they remained throughout the program as steady participants. The Computer Teacher was a barrio resident, and parents did a significant amount of educational work with their children, using the computer as a catalyst. The program model was designed for potential replicability, and as soon as a training program plus advisory services, manuals and an evaluation packet are ready, the program will be available for replication.

The 17 participating families maintained fairly high attendance rates during the 18 week period, particularly given the isolated character of many of the families.

Given that a total of 6 families joined after the program began (1 had a total of 15 weeks and 5 had 11 weeks), we are generally pleased with attendance. The reasons for absences included illness (33%), transportation (25%), work conflict (17%), death in the family (17%) and childbirth (8%). The one family with a very low attendance record lived at a substantial distance, rarely sent their child to school and was involved in a revivalist movement.

The Children. Of the 29 program children, 19 were interviewed at entry and 22 at exit. The youngest were not interviewed. The children were asked how they liked the program; all the children enjoyed the program, and when asked why, over 50 percent mentioned specific computer activities, with fewer responding that they generally had fun and enjoyed the computers and the auxiliary activities.

During the exit interview the children were asked to identify their future learning interests. These responses were classified according to subject area. When clustered by learning interests and the type of student, the results were particularly heartening. (The results in Table 1 pertain only to school-age children).

The poor students had slightly more mentions on the average than the better students. Of particular note is the poor students' emphasis on *language arts* where they were all manifestly weak, affecting their entire learning experience in school. Many mentioned *wanting to learn math,* an area of major dislike upon entering the program. Finally, all children mentioned one or more topics irrespective of whether they had been disaffected from school.

These results were echoed by the parents, 88.9 percent of whom stated that they believed the program had improved their children's interest in learning (one "no answer"). The Computer Teacher observed that 22 (95.6%) out of 23 she evaluated had improved their motivation to learn and their skills and knowledge during the program. The children remained children, however, and continued to list sports and bike riding as their favorite activity.

Table 1
Mentions of Learning Interests by Type of Student

Learning Interest	*Average & Above Students*	*Poor Students*	*Total/ Percent*
Mathematics	5	6	11/55%
Language Arts	0	7	7/35%
Computer Programming	1	0	1/5%
Geography	1	0	1/5%
Total	7	13	20/100%
Total Students Per Type	6	10	16
Average No. of Mentions	1.17	1.30	1.25

We did note that the childrens' aspirations changed during the program. Children's aspirations are altered often, in any case, but these changes are particularly interesting. A total of 9 (40.9%) changed their aspirations by the end of the program period, principally from a *particular* choice to "don't know" (4), a choice to a fantasy role (2), from don't know to a career service or professional role (2) and a career service to a blue collar role (1). It is possible that the program led several children to begin to dream and reassess their future interests; casual observations of this phenomenon have been made by many parents whose children learn, in part, by means of a computer.

With regard to concept and skills acquisition, a Pre-School Abilities Checklist of 38 items was administered at the beginning and end of the program to 11 children from 3 to 6 years of age. These skills were in major cognitive areas such as relationships, sorting, sequencing, initial reading and writing, etc. Over the eighteen week period of the range of acquisition was 2 to 16 items with a mean increase of 8.2 items.

With regard to the 16 school age children, we did not conduct any direct testing due to the wide range of ages; however 13 children were promoted to the next grade. We believe that the program helped some "borderline" students to be prompted, but they will continue to need special attention during the coming academic year. The computer became a learning tool for most of the 22 children and they gained an appreciation of its usefulness. When asked to asses "The Computer House" experience, the children all reported that they wanted to come back again. Their enthusiasm was tempered, however, by critical thought. Asked what could be done "to make The Computer House better," they suggested that more computers and programs be made available and that changes be made in the scheduling and facility.

All in all, the results regarding the children demonstrate that the program objectives were met to a striking degree.

The Parents. Ten parents were actively involved in the program (9 mothers and 1 couple). Nine exit interviews were conducted. The program sought to assist the parents to become teachers of their children, and all of the parents reported that they taught their children various things during the program. Seven parents mentioned cognitive areas and two mentioned more affective or social development areas.

When asked if they had taught their children *more* at home during the program period than before, almost 80 percent of the parents indicated they taught more at home as a result of the program, including 75 percent of those who had not taught their children before. Two sets of parents remained relatively uninvolved at home, although one of them did teach her child in the center. Both of these families have experienced severe family stresses and needs. On the whole, we assert that most of the parents did become more actively involved in teaching their children. The parents were clearly impressed positively by their experience. Nearly 90 percent of the parents said that they wanted to learn more about computers and requested instruction in English general academic skills, programming, mathematics, economics and budgeting, Spanish and health.

Several suggestions were made for improving the program's effectiveness including more space and computers, separate room for the young children and auxiliary activities, longer sessions, prior training for parents, improved organization, more participants, arts and crafts and staff.

The Schools. In all, the schools collaborated in providing reports on 16 children enrolled in the program. These reports were most useful in assessing the children's needs according to the schools.

The children's motivation to learn improved and they made progress in a series of cognitive areas. These advances served to supplement and complement the schools' efforts in similar areas, though they certainly did not substitute for the full school day experience.

As noted earlier, parents became more involved in their children's learning and most reported that they helped their children more with homework and other learning activities at home. In general, the goals set by the program for promoting more positive relationships with the schools were met on several levels.

Conclusion

The CEDEN Computer Education Program successfully achieved the following objectives:

- assisted low-income Mexican-American families to become acquainted with and enthusiastic about computer learning
- motivated both children and parents to enjoy learning, in general, and computer education specifically
- assisted children to learn new concepts and skills
- guided parents to take a more active role in teaching their children in the center and at home
- obtained recommendations for program expansion and improvement from parents and children alike
- secured the assistance of the schools in assessing the children, helping the program to focus on the children's areas of greatest need.

And most importantly,

- the program served as a cultural bridge between the Mexican-American home and the schools, complementing and supplementing formal education.

This small case study points, as well, to the need for program expansion, not only in Austin, but in other communities with similar requirements for improving educational opportunities for low-income families. The computer, used flexibly in community settings, could well become a powerful force for creating greater educational equity.

It is hoped that CEDEN's initial computer education program will serve to stimulate others to begin their own culturally-appropriate programs. If many such efforts were to arise throughout the United States, the predicted role of the computer as yet another instrument of alienation and further inequality, may well be changed into that of a tool to enhance educational equity.

Education and Ecstasy: Computer Chronicles of Students Writing Together*

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> There are, around us, forty learning consoles, at each of which is seated a child between the age of three and seven face outward toward the learning displays . . . When the child takes the chair to begin learning . . . the central learning computer plugs in that child's learning history. The child watches his most recent lesson reeling by on his display. If he wants to continue where he left off, he holds down his "yes" key . . . If not, he presses "no," and the computer begins searching for material appropriate to the child's level of learning (Leonard, 1968).

Leonard, one of the progressive educators of the sixties, believed that the process of learning was ecstasy and that many of the schools of the time were robbing children of that ecstasy. Building on the ideas of Dewey, he asserts that education is an interactive process through which the learner is changed. Children who are actively involved in learning activities that they find meaningful, and have some control over, will discover, Leonard claims, the ecstasy in learning. Looking into the future, he envisioned how the use of computers at the end of this century could extend his notions of self-directed learning. The scenario he created gives students control over the timing and pacing of their lessons but does not extend to ways that the computer itself could be used to accomplish the form of education that he describes so well in the rest of his book. His vision of computers in education lacked crucial interactional dimensions of learning that he describes in his own writing. It left me with a dread for the coming of the computer age. Were our children to be taught programmed sequences of information over which they had no control other than to respond correctly or incorrectly? Would children be socialized by machines and as a result become more machine like? What would happen to the development of interactive skills? Would computer dialogue be the model for human interaction? What would be the role of others in this form of education? Where was the ecstasy in this model of instruction?

These were some of the questions that plagued me when I read Leonard's scenario over a decade ago. The computer age is now upon us and rather than dread, I find myself eagerly implementing a computer curriculum in what we call a "Mental Gymnasium." While there are certainly similarities between Leonard's early vision and what is happening in classrooms using computers and in programs like the Mental Gym, there are many important differences. Foremost is that the forms of social interaction that the computer can facilitate go far beyond what was imagined. Rather then limiting social interaction the computer opens new possibilities for cooperation and cooperative learning. Studies of classroom use of computers have shown that the computer facilitates more not less interaction among students than similar activities without the use of computers (Hawkins, 1983; Riel, 1982).

The advent of the "personal" computer gives children far more power over the technology than Leonard envisioned. Rather than being controlled by the computer and programmed sequences of instruction, children are learning how to make the computer serve their own purposes. Students working together to accomplish their own goals can help them experience the ecstasy in education that Leonard describes.

I am fairly certain that Leonard's current vision for the use of computers in 2001 would be very different than the one he wrote in 1968. I am not able to look as far into the future as he did, but I can describe some current history. In this paper I will discuss the development of a social network utilizing computers--a children's news wire service--and its influence on reading and writing skills and the social dimensions of learning.

The theoretical motivation for the Mental Gym project come from many different traditions. From social and cognitive science we learn that social and cultural systems are important for the development of cognitive skills. Yet schools do not fully exploit social resources for learning. Since social interaction often involves people with potentially diverse goals, we assume, at the outset, that the goals of the learners do not necessarily match those of the teachers. An approach to education that makes social interaction central must address the educational goals of both teachers and students. In following section I will discuss the role of social interaction in cognitive development and ways that social interaction could be more centrally integrated into educational activities.

Social Interaction and the Development of Cognitive Skills

Humans are social beings and carry out their work in concert with other people, yet most studies of cognitive processes are carried out with an isolated person (Nor-

* Special thanks to Bud Mehan for his many useful comments on earlier drafts of this paper.
This research was supported by the Carnegie Corporation (Grant No. DC15 Dept. 05/84) and the Ford Foundation (Grant No. 780-0639A).

man 1981). We know little about how people carry out cognitive activities in social interation.

Social interaction, itself, is a process of coordinated sense-making of the actions of ourselves and others. Since no two people share exactly the same experience, social interaction must be a constructive process of understanding and interpretating (Schutz, 1962; Garfinkel, 1967; Cicourel, 1973; Mehan & Wood, 1975; Mehan, 1983). This means that all participants in even the most routine social encounters take an active role in constructing the meaning of the situation. While sociologists have provided us with many insights into understanding the processes of social interaction, they have seldom looked at the developmental acquisition of the skills needed for interaction (Cicourel, 1973).

Interaction between adults and children is different than interaction between adults in that the adult has a richer interpretation of both what the child knows and needs to know. However children, like adults, are actively constructing meaning from their encounters with others. The developmental work of Piaget and Chomsky has documented the powerful role that children play in developing meaning, while Vygotsky, Dewey and others emphasize the role of adults in this enterprise.

Piaget lays out a developmental progression of intelligence that is based on the children's internalization of their interactions with the physical and the social environment. While Piaget asserts the interdependence of social and individual activity, the role of social interaction in the development of cognition is not addressed directly by him or in the research tradition that he has inspired. In contrast to Piaget, Vygotsky focused on the social and historical influences on the development of cognition. Vygotsky makes the even stronger claim that the mental organization of the mind is highly influenced by patterns of social interaction.

While there are important differences in these research traditions, they share some important assumptions in common. They all assert that interaction is a constructive process in which participants engage in a process of creating understandings. These understandings form the mechanisms of thought. Knowledge is activity and development is the process of internalizing and organizing these activity patterns. Since humans are essentially social, these activity patterns routinely involve interactions with others. Schools, however often set up learning activities that are highly individualistic, thereby ignoring an important resource for learning.

In this paper I will be describing a social system for the development of academic skills. The goal of this project was to explore the social dimensions of learning, encouraging children to participate in the construction of learning environments that alter their interpretation and understandings of their world. The interactive capabilities of computers and students' high interest in them make computer-mediated learning environments ideal for achieving this goal.

THE MENTAL GYMNASIUM: AN EXPERIMENT IN COOPERATIVE COMPUTER LEARNING

We wanted to create social learning environments that provided dynamic support to students participating in meaningful tasks. We chose to work with children that were below grade level and having difficulties in school because the most common approach to teaching these children is to break a task down into smaller and smaller units. Our theoretical interest in the social influence on the development of skills suggest an alternative approach. This was to engage these students in whole tasks and yet provide them the support they needed to begin to work productively. We wanted to help students create their own goals which would help them acquire the skills they were finding difficult to learn in their regular classrooms.

Using the theories of mentioned above and the strengths of different models of education (Kohlberg & Mayer, 1972) as guides, we have been developing and experimenting with educational software systems to provide dynamic support in learning activities.

The bulk of the educational software available for personal computers falls in the category of "computer assisted instruction." This usually means drill and practice with immediate feedback and self-pacing. This use of computers is based on an educational philosophy that Kohlberg and Mayer (1972) describe as a "Cultural Transmission" model. In this model of education, the material to be learned and the sequence in which it is learned is rigidly fixed by the teacher and the materials.

There is another instructional application of computers that includes the "discovery" or learning tools such as LOGO, The Bank Street Writer, Rocky's Boots, and a variety of games that help the player understand concepts that are important in math, science, language or other curricula. This software is based on the educational philosophy that Kohlberg and Mayer refer to as the "Romantic Model." In this approach, that learner is placed in a very rich learning environment but is given very little guidance in terms of what to learn or how to proceed.

The strength of programmed learning sequences and Computer Assisted Instruction is that detailed help and direction is provided. The weakness is that learners are so thoroughly guided through the small pieces of the task that they may lose sight of what they are trying to do. The danger is that they will learn that learning is simply repeating the steps that the teacher provides. By breaking the task down into small tasks, it leaves the students the difficult task of reassembling the pieces to make sense of the whole activity. It also frequently ignores the goal structures of the learner by trying to supplant them with the goals of the teacher.

The strength of software which promotes discovery is that the learner is exposed to a whole activity and is free to explore and learn in his or her own way. The problem with this approach is the lack of direction that novices need to make sense of the activity. The is that the student many be overwhelmed with the complexity to the situation, and give up.

The reason for breaking a task into small steps is so that the individual is not overloaded by attending to everything at once. This is the most reasonable method if the learner operates alone and there is no way to support the learner in the task. An alternate way to arrange for educational activity is to have "the whole task" accomplished in a social setting in which the novices participate initially in restricted ways. By placing the learning of the pieces in the context of the whole task, the learners are not simply learning isolated bits of information, they are learning how that action relates to the task as well as observing what they still need to learn to carry out the task alone. As the learner becomes more skilled the social support can be withdrawn allowing the learner to take over more responsibility for the activity. This notion of dynamic support while participating in the whole task is the method of instruction commonly used in primary socialization for a range of skills in industrialized work settings, and for educational tasks that occur outside of schools.

Before discussing how we implemented this approach using computers, it may be useful to consider a concrete example of dynamic support while participating in the whole task: mothers teaching their young children how to read (Ninio & Bruner, 1978). Young children do not begin with the goal of learning to read. But mother and child sit with a book and carry out the activity of reading. Since the child begins knowing very little about the activity, the book and the mother must carry much of the work of reading. As the child becomes familiar with the patterns, he or she may begin to participate in simple subskills such as turning the pages, or pointing to objects. As the child gains knowledge, what is expected of him or her shifts. Now the child is asked to provide names for objects or to tell what is happening in the story. Slowly the attention is shifted from pictures to text and children begin to recite well learned pieces of the text. Mothers do not start with a fixed notion of the steps or sequence of the learning process. They have some sense of the end point and possible strategies, but their children's behavior will determine the process. The child's skill becomes more and more flexible and over time, the support provided in the book and by the mother recedes and the child is seen as an independent reader.

The activity of reading the book has remained constant through the whole process. What has changed is the support that the child needs to stay in the activity. This changing network of support has been referred to as the zone of proximal development in Soviet Psychology (Vygotsky, 1978) and scaffolding in American psychology (Wood, Bruner & Ross, 1976; Greenfield, 1981). The activity that is accomplished in the social setting, "the zone," provides a good prediction of what the child will soon be able to accomplish on his or her own at some future time. In a sense it turns the competence/performance issue as phrased by Chomsky (1965) around so that performance is seen to precede competence (Cazden, 1981).

In sum, we are referring to "whole activities" as those in which the goals of the students evolve in a way which will subsume the goals of the teacher. This definition does not mean that the goals of the learner are the same as the goals of the teacher. Rather it means that the activities that children find meaningful in themselves are used to serve educational goals. Just as the young child does not begin with the goal to learn how to read, we didn't expect students to begin with the goal to learn how to compute or write.

The Context of the Mental Gym

We used the concept of a gymnasium to characterize our endeavor as it suggested some important features of the learning environment that we sought to create. Athletic activities that take place in a gym are disciplined yet enjoyable. People go to a gym to practice skills so that when they play competitively they will perform their best. A gym is a place where one can try out new skills as well as strengthen old ones, gaining, thereby, a better appreciation of oneself and one's skills. The experts who offer help in a gym generally recognize that there are many different playing styles and they coach players to discover the optimal match between their abilities and the constraints of the game. And finally, people choose to workout in a gym because they value the results of their work.

By analogy, the Mental Gymnasium was a place where children went to develop and practice mental skills in a disciplined, enjoyable way. There was variety in the set of "mental exercises" that students engaged in, but all the training was directed to the development of basic educational skills. These include reading, writing and arithmetic, as well as problem- solving, memory and planning skills. Students were given as much coaching as they needed to begin working, and as they became more skilled, they were encouraged to take on more and more responsibility for the activities. The students were encouraged to chart their own progress and to set their own goals.

The Mental Gym was organized around four learning centers: reading, writing, math and memory. In the reading and writing training centers the children worked with an interactive text system that enabled them to create their own versions of stories with pictures encouraging them to take an active role in the reading and writing process. One of the major activities at these two centers was working as reporters and editors for the Computer Chronicles, a students' newswire service that we created. It is this activity that will be the focus of this paper as it drew all the children in the Mental Gym into an activity that most clearly approximated the system that we sought to create.

Computer Writing in a Social Context

Writing is often considered to be a solitary task in which the writer translates thought into words for the purposes of communication. Learning this form of communication is one of the many complex tasks that take place in schools. Teachers often have a great deal of trouble teaching students to write and find it even more difficult to encourage students to revise and develop texts.

We know from past research that the use of computers alone would not solve the problem of teaching students how to write (Levin, Boruta & Vasconcellos, 1983). The blank screen can be just as intimidating as the blank page. Students with the most powerful editing system still must approach the task of writing alone. While we were convinced that this new medium, in itself, would not transform students with writing problems into skilled writers, it does present a medium that makes a new social organization for writing possible. This organization, not just the computer alone, had very positive effects on the writing process in the Mental Gym.

The computer facilitated three types of interactions that provided the support necessary to involve students in writing. First, computers enabled cooperative work among pairs of children that is difficult to create using pencil and paper. The presence of an "other" during the writing process facilitated problem solving help in generating ideas and immediate responses to the written text. Second, since computers are interactive media, they were used to provide the student with a great deal help with pre-writing or idea formation. This made editing much easier and provided for efficient storage of text for later revision and editing. Finally, computers were used to create functional writing environments, those with a purpose and audience for the stories that students created. When students realized that other people would read their work, not just to evaluate its form, but instead for its content, they took a very different approach to writing and actively engaged in the revision and editing of their own writing and the writing of their peers.

Cooperative Peer and Writing and Revision. Students in the Mental Gym always worked on the computer in teams. This contrasts with conventional arrangements for writing as a solitary activity (Britton, Burgess, Martin, McLeod & Rosen, 1975). Many people have suggested the value of collaborative writing, but it is difficult to share a pencil or to write a text collaboratively on a piece of paper. It is much easier to divide up the work of writing on a word processing system. The display is more public and legible, the keyboard extends in space more than a pencil, and some writing actions (capitalized letters, special punctuation marks) require simultaneous multiple key presses. Students in the Mental Gym and in other classrooms (Levin & Boruta, 1983) spontaneously come up with many different ways of dividing up the work of writing collaboratively.

One of the values of cooperative peer writing is that it provides social resources to confront the blank screen. Even when neither student began with an idea of what to write, the discussion of the problem often presented the solution. In the process of entering the text, the student that was typing was often concerned with local issues such as the choice or spelling of a word. The other student often took this time to determine if the larger unit, say the sentence, made sense and what should come next. Working alone, students often find it difficult to concentrate on the choice of a word without losing their overall plan of writing. Working together, students distributed the task of writing, and helped each other when they had problems.

An equally important function of cooperative peer writing was the immediate audience (the partner) who responded to the text as it was being written. Students frequently challenged one anothers' sentences as "not making any sense" or corrected the spelling of a word as it was typed. Less frequently, but more importantly for the writing process, the students discussed whether two sentences should be conjoined, how run-on sentences should be divided, or how to substitute for overused words. Incomplete idea fragments produced by one of the students were often completed by the other. Research indicates that response to student's writing by peers or teachers results in sufficient increases in the quality of writing (Cooper, 1974; Diederich, 1974). This kind of on-line evaluation is likely to be even more effective then seeing red marks on a paper long after it is written. Students working together were able to provide the kind of individual help for each other that was not commonly available in writing activities in the classroom.

Interactive Texts. The way the computers were used to help support writing in the Mental Gym was a very important element in creating the kind of supportive environment discussed earlier. A Pascal word processor, "The Writer's Assistant," developed in previous research (Levin, Boruta & Vasconcellos, 1983) was used with these children. While students were very excited about using the computer to write, it did not provide enough help for the writing process. Text editors are general purpose learning tools and as such do not provide for the kind of guidance necessary to help students in the writing process. For this specific task we used the a special purpose programming language to create "Interactive Texts" that explicitly shared the initiative for interaction with the learner (Levin, 1982), which enabled us to provide students in the Mental Gym with a dynamic range of support for reading and writing.

This system made it relatively easy for the coaches in the Mental Gym to leave personalized messages to students regarding their progress. It also gave the students a range of options and activities to help them in the reading and writing. When students were assigned to write newspaper articles, the computer support system began by helping them narrow that task down to writing in one of the sections of the newspaper (or to create a new one). If students knew what they wanted to write they would begin writing. If they were unable to think of something they had the option of asking for more help. The computer was used in this activity to provide suggestions of topics, headlines, organizing questions. In other writing activities it provided opening sentences, pictures and sample stories. Maximum support was provided in writing assignments by giving the students a series of options to select among to produce their "own" version of a story. In these cases interactive reading was the first step toward interactive writing.

Writing in response to prompts was very helpful in dealing with the initial blank screen, but often didn't result in fluid text. The responses to prompts and suggestions left the student writers with a rough draft of a story. At the end of this "pre-writing" process, the students used "The Writer's Assistant" word processing system to edit their work. We developed prompted activities in the domains of descriptive, narrative and expository writing, as well as poetry and letter writing.

Functional Writing Environments. One of our strategies for dealing with the writing difficulties of the students involved creating a "functional" writing environments. Functional writing environments are those in which writing is organized for communicative purposes, rather than just as an exercise for a teacher to evaluate.

Many students (and many adults) are much more skilled at sharing their ideas in verbal interaction than in written text. Their own goals often do not place much emphasis on writing, much less mastering the social conventions of writing. They see little purpose in it. To counter this decontextualized approach to writing, we created a functional system for reading and writing that provided an audience for information exchange. This audience was one that the students were unable to communicate with verbally, but was one with which they wanted to share ideas. We created a students "newswire" service known as The Computer Chronicle Newswire. This network made students' concern with the mechanics of writing secondary to, but instrumental for, communicating clearly. Within this framework, we were able to explore more fully the influence of "audience" on students' writing and revision.

Computer Chronicles Newswire

The Computer Chronicles Newswire was a writing network that integrated a computer-supported writing system, cooperative problem solving, and newspaper reporting into a larger network of communication. The network was set up with the help of of Jim Levin (UCSD) and Ron Scollon (University of Alaska). It began by linking together five schools, two rural and one city school in Alaska and one suburban and one rural school in California. Each classroom generated and edited articles stored on floppy disks, which were sent out to all the other classrooms. Each classroom chose the articles they wanted for their own local version of The Computer Chronicles Newspaper. The news network was explicitly modelled on the international news wire services that are important to adults. Whenever possible we helped students to see the parallels between their work and the work of newspaper reporters and editors.

This network enabled students who knew nothing about each other personally to share conceptions of their lifestyles and worlds. The differences among the life styles of the participating students made it important for the students to write good descriptive accounts of their everyday activities. The students who participated in the network enjoyed the contact with students in other locations and soon requested that we extend the network to include their favorite city or country.

The children who came to the Mental Gym to work on reading and writing difficulties became reporters and editors responsible for the production of the Mental Gym version of The Computer Chronicles. These children began working on the computer with some vague notions of a newspaper and of sending stories to kids in Alaska, New York and other places. Their understanding and interest grew as they became more aware of what it meant to participate in such a network.

This functional writing system contained a number of crucial features. The Computer Chronicles Prompter, an interactive writing system was developed to give students prewriting help in making decisions as to what to write and to help them organize their ideas. Students always worked in teams either to generate new articles or to edit those received from other students. In addition to computer and peer support in the Mental Gym, the students had the help of "computer coaches." The coaches at the gym were university undergraduates who knew very little about computers but who could provide encouragement and serve as "adaptive experts" when problems arose. Another important element of the writing environment was the Editorial Board Meetings which were held to determine which articles would be accepted for their newspaper. The students' production of the Mental Gym version of the Computer Chronicles was the explicit goal that organized their activities, although they were just as eager to see their stories published in The Computer Chronicles produced by each of the schools.

Writing Skills in the Mental Gym

What have we learned from our efforts in the Mental Gym? What can we say about change in students' writing abilities when students participate in this type of a network? While the changes in our posttest measures after a few months were not striking, the change in the students' attitude towards reading and writing were (cf., Center for Social Organization of Schools, 1983). The children regularly showed their work to both their classroom teachers and parents. The students eagerly took stories home to read and evaluate and in some cases spent time at home preparing for their work in the Mental Gym.

The Mental Gym worked with eight students and although all participated in the Editorial Board meeting, reading and evaluating stories, they did not all work on writing and editing articles on the computers. Each pair of students were referred to the Mental Gym to work on specific skills. The students working at the math center did not do any writing or editing on the computer. The students from the Reading and Memory Centers each spent part of their time writing and editing stories, while those at the Writing Center spent more than half of their time in the Mental Gym working on newspaper stories.

Pre- and post-tests were given to measure quantitative change in the students' skill. We were most interested in looking more closely at the process of change. The computer stored all texts the students produced and "keystroke" data on all writing and editing. Each session with the computer was audiotaped and observational notes were kept on the students' interactions with the computer, each other and with computer coaches. This enables us to examine closely the process of writing and the kind of errors that students made and corrected. While some of the process data is still being analyzed, the following findings indicate the effectiveness of this computer network on the development of writing skills.

Pre- and Post-tests. All students in the Mental Gym who worked with the computer interactive writing and editing system were given a writing pre-test. A prompt for expository writing was chosen because this form of writing is not routinely focused on in the classroom and would be important in writing for a newspaper. The pre-test writing prompt asked students to describe an activity in the classroom.

> Think of some thing you do regularly at school. It could be anything, like how you do your reading or math lessons, getting ready for the beginning of classes, the way you go to the library or lunch, something that happens at P.E., or any other thing you do at school. Imagine a new student is coming to your school and wants to know how to do this activity. Think of how you do this activity. Think of what you do first. Then think of what happens next, then what, and what happens last. Think of all the steps in order so you can write about it.

The post-test was identical except that the students were asked to write about something they do at home. And, instead of a new student, they were told to imagine that a student in Alaska wanted to know about what they did at home.

The stories written for the posttest were longer on the average (79 vs. 53 words per student). The difference is greater if we look at the number of words that were used to directly describe an activity (63 vs. 29 words per student). Several students in the pre-test spent most of their time writing about "the new student" and very little time describing the activity. In the post-test they all moved quickly to the task of describing the activity.

These comparisons indicate improvement in the writing skills of these children over a half year period. We are currently looking at measures to see if there are qualitative changes in the writing samples. It appears that for some of the children there were clear signs of improvement while for others the quality is about the same. Without a control group, it is difficult to argue that any of these changes are due to their work in the Mental Gym. These results are, however, consistent with previous research which indicated that students writing with computer produce longer texts while maintaining similar levels of quality than children who do not use computers (Levin & Boruta, 1983).

The most striking difference observed is not captured in these measures. When the student were given the pre-test, they complained about it, needed to have it read many times, in some cases needed an adult to sit next to them prompting them to select an activity, think about it and finally write something. The students did not write easily and, if it there had not been the promise of working on the computer, some of the students may not have cooperated.

When the post-test assignment was read the students picked up their pens, asked a few clarifying questions and began writing. No one complained and the prompt did not need to be repeated. The students' attitude toward writing had changed. They were more confident of their ability to write and had a better understanding of the need for explicit description. The students, themselves, in individual interviews often commented on how The Computer Chronicles had helped them learn how to write.

Reporting from the Mental Gym. Most of the Computer Chronicle stories written in the Mental Gym were produced by the two students who were selected because of their difficulties in writing. One of the students, D, was referred because he routinely failed to turn in writing assignments and because he had great difficulty in writing. The other student, H, was described as having trouble with the mechanics of writing. Our pre-test writing samples were consistent with teacher reports. D took a very long time and needed much prompting to complete a task. He wrote very short sentences, but they were directly related to the topic and made very few errors. H had less difficulty putting words to paper but he had trouble staying on a topic and his syntax and spelling were poor. The students had complementary strengths and weakness which we felt would make them a good working team.

The students spent the first two weeks learning how to use the computer, using a typing tutor program to help them learn the keyboard, and interacting with story makers to help them learn how to use the interactive system. The students began writing stories for the Computer Chronicles in the third week of Mental Gym.

During their first month, the students wrote five stories for the Computer Chronicles. Four of them were composed at the computer with the support of the computer prompting system, each other and a UCSD undergraduate who was serving as their computer coach. The average length of these stories was 24 words and they generally did not provide much useful information on a topic. The fifth story was a collection of jokes for the fun section of the newspaper. The students had borrowed a book of jokes from the library to use to help them think of jokes. The jokes were entered during the same period of time as the other four stories but contained a total of 98 words. This is important because it demonstrates that the limited length of these early stories was *not* due to a lack of computer or typing skills. The students simply did not know what to write and needed a great deal of prompting to get started. The observational notes from this early period indicate that both students were excited about writing on the computers and worked very hard to generate stories but needed help in determining what to write, the same problem the teacher reported about their classroom work.

As the students received stories from other schools and they began to get a better idea of the news network, the length and quality of their stories began to increase. During the second month, the students wrote seven stories and the average length of each was 78 words, almost triple what it had been during the earlier period. The stories improved in quality and the students were much less dependent on their computer coach for help in the writing process. The coaches began to take a more distant role spending their time taking notes and encouraging the students to turn to each other or to a dictionary for help.

During the final month, the computer coaches were phased out and the students worked alone at the computer. The students wrote seven stories during this period and the average length per story was 68 words and these stories provided adequate information about the particular topics. The stories of this period are not much different from the second, but now the students are able to do this work with almost no adult guidance. They have taken over the role of asking each other questions and thinking of what needs to be said to tell other students about an activity. The change is not in the level of skill but in the students ability to handle more of the task themselves.

Another important area in which we saw change in the writing process was in the students' attitude toward editing. As students worked on these stories, editing became a routine practice for them. When students located errors made earlier in their text, they were not discouraged. They indicated that they would correct it when they were editing. This sense that errors could be easily corrected at a later point encouraged fluency at the early stage of the writing process. When the students first started working, they obtained a printout of the article directly after the first draft. As editing came to be an accepted second step, they no longer obtained printouts of their early draft, but waited until they were finished editing the story.

A further indication that editing was becoming an expected part of any writing of these students came from D's posttest. When I came over to check how he was doing, he said, "Oh, I'm finished writing, I am just editing now."

The Editorial boards provided the kind of feedback that helped them understand that revision is also an important part of the writing process. At the very first editorial meeting the students had rejected two and three sentence stories about sports because they lacked details and accepted one story about soccer that described the goal of the game and gave a description of how the game was played. When these students' story on Coneball (written during the early period) was about to be read, the authors "pulled" the article and said that they would fix it. They saw their own writing in the context of the evaluative framework that they had help create. It was not acceptable and they knew it. They also had a good idea of how to fix it: it needed more details. They revised the story and in a later board meeting it was accepted for the newspaper. They were as pleased as we were that they had fixed it themselves without having anyone tell them what needed to be done.

The students worked cooperatively and benefitted from each other skills. When I asked each of the students alone what they learned from the other student, both D and H indicated that D had helped H with spelling, a point confirmed by our observers in the Mental Gym. However, towards the end of the session, on at least two occasions, H had corrected D's spelling marking the occurence with great pride.

Since our notes indicated that H often took the initiative at the beginning of the sessions, we assumed that H took a more active role in determining the topic of writing. When asked about this, H disagreed, saying that before they came to Mental Gym they would get together and talk about what they would write about. Sometimes they looked around the classroom for ideas; one time they went to the library for help. I asked him where the idea for a recent article on the San Diego Padres had come from. He said that he got the idea while watching baseball over the weekend and they both thought it would be a good story.

This emphasis on "team" rather than individual work was also evident in D's interview. He had listed language and reading as his least favorite thing to do in school and writing and editing for The Computer Chronicles as his favorite activity in the Mental Gym. When asked to explain this apparent contradiction, he said that he didn't like writing in the classroom "because your hands get tired after about three sentences and you feel like just leaving it." In contrast to writing in the classroom, the cooperative activity in the Mental Gym was fun because "Me and H are a team, we get to do it together. In the class we don't get to discuss anything. H gives me ideas."

These students worked exclusively on interactive reading and writing programs in the writing center. Although some of the story making activities did include graphics they were not given any "games" to play. In all of the other centers which were clearly visible to them, educational games were routinely used to provide practice in the concepts learned. We had selected some "game" format activities in writing that we could use if the students complained, but we wanted to see if the interactive text system could compete successfully with these other games. The students worked enthusiastically and only asked once over the twelve week period to do any of the other activities. They asked to work with Musical Spell (a spelling exercise that maps musical notes to the alphabet) the week that it was introduced to the other students. They were given that option several times and played the game for two half hour sessions. For the rest of the time they were content to work with "words." In fact, the students from the math center asked on two occasions to be permitted to edit stories for the Computer Chronicles! This together with the students' own reports indicate that the students enjoyed writing in this functional setting.

The classroom teacher indicated that both students wrote more easily in the classroom, although she was disappointed that she did not see more improvement in H's spelling. She reported their changed attitude toward writing as the most noticeable change. They brought her every story they wrote to look at and were very proud of the finished newspaper.

Twelve weeks is a relatively short time in the life of students, but in this time we were very pleased with the amount of change we saw in the work of both students. Their positive approach to writing as a form of communication, their understanding of the need to edit and revise and the value that they placed on knowing how to spell correctly are all likely to lead to continued improvement in writing skills.

We were able to create a learning environment that began by providing them with as much support as they needed to write. In this supported system, their writing improved steadily. At the end of the session, we were pleased to see them continue to work at this level but relatively independent of adult guidance. In this way we were able to create the kind of system described earlier in which experts and novices begin an activity together with the experts doing as much for the "novices" as is necessary to create the joint activity, and then systematically removing the help as the student demonstrates skill.

Editorial Board Meetings. We also saw individual development of the students' writing skills from participation in the Editorial Board Meetings. When stories came over the "newswire" from other schools, the students were eager to read them and express their views about which ones were good stories. All the students *willingly* gave up part of their recess to participate in Editorial Board Meetings to read and evaluate stories. This voluntary participation during their time is a measure of interest of the students. This willingness to do reading and editing during "recess" time is somewhat surprising, in that students who are having trouble in academic subjects have been found to be extremely skillful in avoiding situations in which this trouble might be made more evident (Riel, 1983).

Each story from the news service, including those written by students in the Mental Gym, were read by one of the students. Then the group made a decision either to reject the article, or to accept it with or without revisions. A decision was based on a majority vote plus a formulation of a "good" reason for its acceptance or rejection. The role of the adult coach was only to record the results and to judge whether or not the reason given was acceptable. Otherwise, it was *their* meeting.

The students began with simple reasons such as "too short" but soon found a short article that was acceptable because it had "good details." The students quickly determined whether they liked or disliked a story but they were less aware of why they made these evaluations. Having to find a reason helped them understand their evaluations.

The major concern of The Editorial Board was that an article "make sense" as well as be well written. When they edited stories they combined and divided sentences, removed redundant information and tried to finish incomplete statements as well as correct spelling, capitalization and verb tense errors. When students were satisfied with an article, it was accepted. Since students saw this as their newspaper, they collectively worked to improve the articles.

While students' evaluation and editing were improving, there was another important kind of learning taking place. Students were learning about life styles and customs that were very different from their own. This provided them with a new perspective on their own lives. They began to understand how their culture was both similar and different from that of these other children. It provided them with direct communication with other children so that they could share the information that they felt was important.

They were also beginning to understand the role newspapers play in a society and how such communication networks function. Students were forming their ideas about what makes a story "news worthy." They were dealing with issues of what is appropriate and inappropriate writing for this media. A few examples from the Editorial Board Meetings will illustrate children struggling over these issues.

A story describing a family opening presents on Christmas morning was received in January from a student in Tununak, an Eskimo village on the Bering Sea in Alaska. The first reading of the story lead to concerns over grammatical errors, and a pair of students quickly volunteered to fix it. They fixed some of the errors and removed sentences that were redundant. The story came back to the Board and space constraints on the layout of the page lead to the discussion of its content. One student argued that the story should not be accepted because it did not tell any news. It just told about what everybody does on Christmas Day. Another student agreed but then a third student volunteered that not everyone celebrates Christmas in the same way. For example, he argued people in Africa don't do the same thing therefore this Alaskan story was news. Students were persuaded by this argument until someone else reflected that children in Africa would not see the newspaper. The final decision was not to make extra space for the article but to hold it for available space. The students had discovered the use of a "filler" story.

Another story entitled "Helping" was about two peolple named Charlie and Claire. In the story Charlie tells Claire to do things and Claire does them willingly. Some students saw Charlie as the husband of Claire and others saw him as her father. In either case, the students argued that it was not a story about helping, but instead was a story about bossing. They all quickly agreed that they did not approve of Charlie's behavior and did not want that story in THEIR newspaper. When pressed for a reason for rejecting the story, they said the story did not match the headline and that bossing wouldn't be a good topic for a story.

To summarize, the Editorial Board Meetings served a number of important functions. They set new standards for stories that students would write in the future as well as guides for how old stories might be re-written. They provided motivation and suggestions for the editing of stories. Topics of other students provided ideas for future articles. The students learned about themselves and others through the medium of print. They began to understand why people write things and what makes a story interesting to other people. This last issue became particularly salient when the students saw which of the stories they had written appeared in the Tununak, Wainwright, Vista or Fairbanks editions of the Computer Chronicles.

All the students in the Mental Gym dealt with a range of issues from grammatical problems to concern for the content of the articles. But more important, the educational goals of teachers (reading, writing and revision) were being accomplished while students pursued their own goals of creating a written record of what they were sharing and learning from their distant peers. Even though the computer and the computer software were integral parts of this system, it is important to note that much of this learning took place in group discussions with printed texts and pencils.

CONCLUSION

The theories that have framed this project all describe education as a constructive process that results when the learner takes an active role in interaction with his or her environment. After more than a decade, a rereading of Leonard's book indicates that he shared this conception of education. He describes education as a process of change that comes from interactions with the environment shaped by culture yet internally driven. Ecstasy is the joy and delight that accompanies that change. Throughout his book, he tries to expain what he means by ecstasy, but in the last pages of his book, he uses a personal story to convey how learning that is creative results in ecstasy. At the age of fifteen with the guidance of a friend, he built his own radio. When he finally soldered the last connection and solved all the problems, he reports:

> . . . a universe poured into my room from the star-filled night. I spun the dial: a ham in Louisiana, in California; shortwave broadcasts from England, Germany, Mexico, Brazil. There was no end to it. I had put our new sensors. Where there had been nothing, there was *all of this.*
>
> Ecstasy is one of the trickier conditions to write about. But if there is such a thing as being transported, I was transported that night. And I was, as with every true learning experience, forever afterwards changed (Leonard, 1968, p. 239).

I think the students who have participated in the Computer Chronicles network, those in the Mental Gym and those as far away as in an Eskimo village on the Arctic Ocean, have experienced this sense of ecstasy. I don't think that this excitement was the sole result of working with the computer any more than the excitement that Leonard expressed resided in the soldered connections in his radio. In both cases the technology is a means of communication. It is the control over the technology, and not the technology itself, that leads to ecstasy. Leonard learned how to build his radio by working closely with a good friend. It was this friend that provided the support, encouragement and sometimes critical clues as to how to continue. When the radio finally came to life, Leonard experienced a sense of accomplishment, made possible by his interactions with his friend, but that now had become his own.

The students that we worked with experienced a sense of power and control over the meduim. The computer was a tool that they used to help them share life experiences of children who were living in a world very different from their own. Writing and reading, editing and revision became means to serve this goal. The students helped one another and received help from the computer program and the computer coaches. But like Leonard's radio, their newspaper had become their own.

It was not just working with computers, but the sense of control over the computer, their use of the computer to create a direct link with other children and the sharing of their ideas and lives in print, that resulted in expressions of ecstasy.

References

Britton, J., Burgess, T., Martin, N., McLeod, A., & Rosen, H. (1975). *The development of writing abilities (11-18)* London: MacMillan, 1975.

Cazden, C. (1981). Performance before competence: Assistance to child discourse in the zone of proximal development. *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition, 3,* 5-8.

Center for the Social Organization of Schools (CSOS). (1983, April and June). *School uses of microcomputers: Reports from a national survey* (Isuues 1 and 2). Baltimore, MD: The John Hopkins University, CSOS.

Chomsky, N. (1965). *Aspects of the theory of syntax.* Cambridge, MA: M.I.T. Press.

Cicourel, A. (1973). *Cognitive sociology.* London: MacMillan.

Cole, M. (1981). *Society, mind, and development, and the zone of proximal development: Where culture and cognition create each other.* (Tech. Rep. No. 106). San Diego: University of California, Center for Human Information Processing.

Cooper, C. (1975). Research roundup: Oral and written composition. *English Journal, 64,* 72-74.

Diederich, P. (1974). *Measuring growth in English.* Urbana, IL: National Council of Teachers of English.

Garfinkel, H. *Studies in ethnomethodology.* Englewood Cliffs, NJ: Prentice-Hall Inc.

Greenfield, P. (1981, March). *The role of scaffolded interaction in the development of everyday cognitive skill.* Paper presented to the Society for Research in Child Development.

Hawkins, J. (1983). *Learning LOGO together: The social context* (Tech. Rep. No. 13). New York: Bank Street College of Education, Center for Children and Technology.

Hawkins, J., & Sheingold, K. (1983, March). *Programming in the classroom: Comparing ideal with what happens.* Paper presented at the Conference on Joint Problem Solving and Microcomputers, University of California, San Diego, La Jolla, CA.

Kohlberg, L., & Mayer, R. (1972). Development as the aim of education. *Harvard Educational Review, 42,* 449-496.

Levin, J. (1982). Microcomputers as interactive communication media: An interactive text interpreter. *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition, 4,* 34-36.

Levin, J.A., & Boruta, M.J. (in press). Writing with computers in classroms: "You get EXACTLY the right amount of space!", *Theory Into Practice.*

Levin, J.A., Boruta, M.J., & Vasconcellos, M.T. (1983). Microcomputer-based environments for writing: A Writer's Assistant. In A. C. Wilkinson (Ed.), *Classroom computers and cognitive science.* New York: Academic Press.

Mehan, H. (1983). Social constructivism in psychology and sociology. *Sociologie et Societes, 14*(4), 77-96.

Mehan, H., & Hood, H. (1975). *The reality of Ethnomethodology.* New York: Interscience.

Ninio, A., & Bruner, J. (1978). The achievement and antecedents of labelling. *Journal of Child Language, 5,* 5-15.

Norman, D. (1980). Twelve issues for cognitive science. *Cognitive Science, 4,* 1-32.

Piaget, J. (1968). *Six psychological studies.* New York: Vintage.

Piaget, J. (1973). *Main trends in interdisciplinary research.* New York: Harper & Row Publishers, Inc.

Riel, M. (1982). *Computer problem-solving strategies and social skills of language-impaired and normal children.* Unpublished doctoral dissertation, University of California, Irvine, CA.

Riel, M. (1980). *Investigating the system of development: The skills and abilities of dysphasic children* (Tech. Rep. No. 115). San Diego: University of California, Center for Human Information Processing.

Schutz, A. (1962). *Collected papers: The problem of social realities.* The Hague: Martinus Nijhoff.

Wood, D., Bruner, J., & Ross, G. (1976). The role of tutoring in problem-solving. *Journal of Child Psychology and Psychiatry, 17,* 89-100.

Vygotsky, L.S. (1978). *Mind in society.* Cambridge, MA: Harvard University Press.

Computer Conferencing: A Medium for Appropriate Time

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Fred Erickson reintroduced from Greek the distinction between *chronos* and *kairos* as a way of reorganizing our thinking about time and timing (Erickson, 1980). *Chronos* is clock-governed time as opposed to *kairos* which is time geared to appropriateness. *Chronos* time is time entrained to an arbitrary standard. Only in *chronos* time is it possible to say that an event will happen at two o'clock, or that another event will happen on Tuesday. In *kairos* time an event occurs when it is appropriate for it to occur. *Kairos* time seems more related to sequences of events, order among events, than *chronos* time. *Chronos* time emphasizes the independence of events from each other.

Much discussion about media of communication has revolved about the contrast between what has been called "real" time and what has been called "non-real" time. Researchers in using this distinction have been calling our attention to the fact that in the use of some media there is an entrainment to each other's rhythms among the participants in an interaction. The typical "real" time medium is usually a face-to-face, small group, informal interaction. The typical "non-real" time medium is the printed book. The distinction being highlighted is the degree of feedback from other participants immediately available in the interaction (Black, Levin, Mehan and Quinn, 1983; Scollon and Scollon, 1982).

This distinction then gives a basis for taxonomizing communications media. Oral communication is real-time based whereas print, tape recorded, video recorded, or asynchronous computer communications are based in non-real time. Yet while it is easy to place media somewhere in this taxonomy, it is not at all clear, at least to me, that this distinction has helped us at all in understanding what we intuitively know about differences among these media.

Some time ago in these pages we introduced the notion of *focus* (Scollon and Scollon, 1980). We argued that we might get further in our understanding of media by attending to the nature of the interaction and treating the medium as one of several factors which condition a more or less *focused* kind of interaction. We suggested that where there were time limitations an interaction would be more focused than where there were not. We suggested that increasing the number of participants would increase the degree of focus of the interaction. We finally suggested that where some medium of communication intervened between the participants the situation would be more focused than where there was no intervening medium.

Focus in our view meant a limit on the degree of flexibility in negotiating the sense of the situation among the participants. A more focused interaction leaves less latitude for negotiation than a less focused interaction.

While we feel that it has been productive to speak of communication in the vocabulary of focus, this vocabulary has still not been very useful in accounting for some situations. We know for instance that if we compare face-to-face class meetings, asynchronous computer conferenced classes, audio-conferenced classes, and print-based instruction, it is not at all easy to order these in the vocabulary of focus. Furthermore, to the extent we feel we want to do this, there are significant numbers of participants who do not agree at all with our analysis. We wanted to say, for instance, that real time, face-to-face interactions in small groups are generally less focused than any kind of interaction involving an intervening medium and a larger group of participants. We found, however, that a very large group of participants (some 50) enrolled in a class taught almost exclusively by asynchronous computer conference felt considerably less focused than much smaller, face-to-face classes.

The problem, I believe, is that the notion of "real time" is quite misleading. I suggest that the distinction introduced by Erickson of *chronos* and *kairos* comes much closer to giving us a useful vocabulary for talking about the asynchronous computer conference. One reason for this is that some kind of "real time" status is inherent in each medium while any medium can be geared to either *kairos* or *chronos*. The asynchronous computer conference is by definition something which takes place out of real time. The writing and reading of printed communication, again, are inherently separated from each other in time. And yet we all know well the difference between the book read when geared to *chronos* is a very different event from the book read when geared to *kairos*.

What is peculiar to the asynchronous computer conference is that the activities of the participants are geared to *kairos* time. It is typical for individuals to have very different rates of participation, some dropping in as often as several times a day and others only each week. It is also typical for some to have a great deal to say for a while and then relatively little for a while. As an example of the difference in two fairly comparable situations, I frequently get messages from students in my classes which have been sent in the middle of the night. This is a (*chronos*) time at which it is generally impossible for a student and a teacher to have any form of contact and yet as a message dropped off in a central computer mailbox it is entirely appropriate for that student to sent it then while the idea is new and for me to receive it at the next convenient time I check into the conference.

In contrast, ideas deferred until the next scheduled class meeting often get lost or sometimes distorted by appearing in the context of another discourse.

Viewing computer conferencing from this perspective resonates with our general finding that the less time structured an interaction is the more effectively computer conferencing can be used as the medium. We find that loosely knit conversations among friends are very suitable in this medium while it is virtually impossible to manage a top-down, hierarchically directed form of interaction such as a lecture class. This leads then to seeing at least some basis for the finding that some people take to computer conferencing quite easily and naturally while others resist it or even find it repugnant.

There is an interesting irony in suggesting that the central defining characteristic of the computer conference is that it is not entrained to *chronos* time. This irony is that the most frequent justification given for an electronic messaging system is speed of delivery. In my view this speed is almost incidental. What is significant in the view I am presenting here is that a computer conference allows the time of participating to be governed by the sense of appropriateness of the individual. It is true that sometimes the most appropriate response is a quick response and in those cases the speed of computer conferencing is a positive aspect.

This irony lies behind a recurrent institutional problem regarding electronic mail systems. Electronic mail systems are set up within universities, businesses, and governmental agencies on the assumption that it is *chronos* governing their operation. They are valued for their speed and efficiency of operation. It is often the case, however, that these message systems become the culture for the growth of complex networks of highly informal *kairos*-timed communication both within the institutions and between the institutions and others who have somehow gained access. At this stage the institution steps in and tries to eliminate this "frivolous" use of the mail system. It is claimed to be inefficient and a waste of powerful computing resources.

This problem of the "frivolous use" of electronic mail seems to indicate that the property of being *chronos*-timed or *kairos*-timed is in no way inherent in the medium itself. The problem lies elsewhere in the assumptions people make about the nature of communication itself. For those who want *kairos*-timed interaction, however, the asynchronous computer conference is an effective medium.

References

Black, S.D. , Levin, J.A., Mehan, H., & Quinn, C.N. (1983). Real and non-real time interaction: Unraveling multiple threads of discourse. *Discouse Processes, 6*.

Erickson, F. (1980). *Timing and context in everyday discourse: Implications for the study of referential and social meaning.* Sociolinguistic Working Paper No. 67. Austin, TX: Southwest Educational Development Laboratory.

Scollon, R., & Scollon, S.B.K. (1980). Literacy as focused Interaction. *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition, 2*(2), 26-29.

Scollon, R., & Scollon, S.B.K. (1982, October 5-9).]RUN TRILOGY: Can Tommy read? Paper presented at the symposium, *Children's response to a literate environment: Literacy before schooling.* University of Victoria.