- 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-

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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 people 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.

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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