LOGO
Learning In A Computer Culture

SAINT PAUL PUBLIC SCHOOLS
LOGO STUDIES

Observations, Anecdotes, Effects

1982-85

St. Paul Public Schools
St. Paul, Minnesota

September 1985
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INTRODUCTION

ST. PAUL LOGO PROGRAM

The St. Paul Logo Program was initiated in November, 1982. It began with twenty-six teachers in seven schools, and has since expanded to a network of some two-hundred persons in sixteen schools. Six additional schools will be added in 1985-86.

Logo in St. Paul is a school-based program, i.e., ownership and responsibility belong to each school. Logo is one part of a larger change effort and is designed to serve as an intervention in learning and learning environments. The focus is on staff development.

There are six interacting levels of development:

- An introductory workshop of forty hours recognizes that teachers and principals function at different levels of personal and professional development. The workshop environment is structured to be secure and non-threatening. There is a balance of theory and skill development and an emphasis on building school-based support teams.

- Internal support systems function in each Logo school. On-site monthly inservice days provide ongoing follow-up and development. On-line assistance in the classroom is available from Logo resource teachers, community volunteers, and college interns. The power of direct feedback to teachers allows teachers to clarify their understanding of Logo concepts, to internalize the Logo process, and to adapt Logo over time to their own and students' needs.

- Intermediate-level workshops are conducted for those teachers who want "more Logo." The format ranges from individualized open lab environments to direct skill instruction.

- The development of a leadership group of teachers is central to the continued growth and development of Logo in St. Paul. This core group is responsible for teacher training. It is supported with advanced training provided by LCSI and the MIT group.

- Parents and community are involved in informational meetings and workshops. These collaborative efforts, initiated by individual schools, are intended to increase community awareness, understanding and support.

- The response of the larger community is testimony to the power of public/private partnerships. The St. Paul Logo Program has developed working relationships with MIT, Macalester College, and the Saint Paul Companies.
Logo is more than Logo. It is a philosophy of education and a language of learning. This is what we see in the third year:

- Changes in classroom organization
- Increased sense of teacher efficacy
- Co-learning between teacher and teacher, between student and student, between teacher and student
- Teacher recognition of different styles of planning, problem solving, and critical thinking
- Increased teacher expectations especially of low-achieving students
- Effective mainstreaming of special education students especially at the secondary level
- Strategies of direct classroom intervention and teacher assistance
- Leadership at the building level
- Internal support systems at each site
- Integration of community resources

The impact of Logo on learners and learning environments involves incredibly complex relationships. We have yet to tease-out and comprehend the nuances and subtleties of what we see. A new culture is emerging; we call it a Logo culture. We are too close to it to fully understand it, but it is there being shaped and molded by the technology and by the users of the technology. Three observations:

STRONGER LEARNERS...stronger in the sense of learners who use their intuition, who claim ownership of their learning, and are thus free to risk in order to learn. We see students using learning modalities that are not tapped by the present curriculum.

REAL WORK...a work intensity characterized by the frightful toil* of work that is satisfying and worthwhile. It is a work ethic that encourages co-learning—which is more than sharing—and a blurring of gender roles and age differences.

EXPANDED VISION...in the shape of new art forms that expand our vision and guide us toward a clearer understanding of our changing world. Artists have historically operated at the leading edge of social and cultural change. The fluid rhythms and transformations of Logo images are a visual expression of a new aesthetic.

*T.S. Eliot
The following collection of papers is a tribute to the students and teachers in the St. Paul Logo Program. The observations, anecdotes and effects are their record of the Logo experience. They help us understand learning and teaching, and move us to find new ways of looking at schools and at schooling.

The voice of the turtle is strong.

Geraldine Kozberg
September 1985
LOGO OBSERVATIONS
February 1 - March 15, 1983

The following report is based on approximately twelve hours of observation in elementary classrooms in the Collaborative schools. The research objective during this period was primarily exploratory. I approached the field with the research question defined in broad terms: How does Logo impact on learning? While twelve hours of observation is far too meager to provide any definitive answers, I hope to provide documentation on the process of interaction between the child and the computer within the social context of the classroom. The physical location of the computer in the classroom also made it possible for me to observe the interaction between the child and the teacher, and to record the spontaneous interventions of other children in the learning process. The data gathered thus far will be used to develop specific hypotheses and categories of behavior that will be used as the basis for further systematic observation.

ISLANDS OF LOGOLAND?

Logo, in the view of its designer, Seymour Papert, was developed with the object of creating computer-based learning environments in which children can learn mathematics and other areas of "formal learning" in a natural fashion. The child in Logoland interacts freely with the computer in a non-authoritarian environment, and in the process of becoming his own programmer, develops his own "models" or intellectual structures.

In all the classrooms I visited, the computer is located within the physical space of the classroom. In almost all elementary school classrooms, Logo commands are written on the blackboard or on gaily colored posters. The display of symbols makes it possible for any child to approach the computer and experiment. It also became apparent to me that the child on the machine can get quite immersed in Logo while the rest of the class is engaged in routine activity. The computer also appears to be a gathering place for children; groups of children were observed to cluster around the computer at the end of class periods when movement is generally allowed. Sharing of information was observed at these times. "Push CTRL-C to get out of the editor"; "Type ST if you've lost your turtle"; "Push PU if you want the turtle to become an eraser, and push PD if you want the turtle to become a pen again" are some comments I heard in 3rd-and-4th-grade classrooms.

Papert sharply differentiates Logoland from the domain of traditional school math; in Logoland, the child experiences the math problem as a personal need. There is a powerful affective component here. The child, working with Turtle geometry, wants to "draw" something that makes sense. In my observations, I found ample evidence for the existence of this affective component.
In most elementary school classrooms, the children have a predetermined
Logo schedule, and bi-weekly sessions of 15-20 minutes appear to be popular­ly used. A 6th grade teacher mentioned that her class voted in favor of
two short sessions versus one longer one. I noticed that children are almost
never late for a Logo session, and they leave the machine with reluctance.
Informal rules appear to have evolved among the children that make it very
difficult for a child to exceed his allotted time. His classmates are quick
to point out when a change of turn is due. I only observed two incidents
in which the child was reluctant to get on the computer. In both instances,
the alternative to Logo was a game that the other children were playing.
Thus, while Logo does appear to exercise considerable appeal, it does not
necessarily take precedence over social contact with other children.

There is more, however, to the concept of Logoland or the "micro-worlds"
that encompass the child and the computer than freedom of access to the
computer, a non-authoritarian environment, or even the affective element.
Papert refers to these micro-worlds as "incubators of knowledge", and Logo
is the heuristic device with which the child develops his own intellectual
models. What evidence did I find to support this notion? On examination
of all the diverse incidents I recorded, I found that I could classify
behaviors observed on the machine in terms of two broad categories: "play"
and "problem solving" or "goal directed" behavior. The definitions of
these categories are, at present, rather hazy. Behavior that starts as
play can become goal directed or vice versa. However, I shall attempt a
definition and draw on case material for empirical support.

PLAY

The child who is "playing" is one who has no definite conception of what he
wants to achieve; he is content to explore the various commands, and experi­ment with colors and visual images. The actions of the Logo novice who
pushes FD 1234 and changes background color several times is an example of
what I call "play." Play on Logo is serendipitous. For instance, a child
who is randomly pushing keys and accidentally types ED, finds he is in the
Editor, and his action opens up a new realm of activity: He has to figure
out what to do next and also how to get out of the Editor. This is the
point where intervention normally takes place; he asks the teacher or
another child. In terms of my definition, play does not have to be totally
random activity; there can be method in play. The following two incident
may both be classified as "play", but are of a qualitatively different sort:

*Jenny, a second grader, was on the computer for approximately
15 minutes. She appears to be a novice to Logo. She looks at
the Logo chart on the wall and types FD, BK, and RT commands.
She then changes pen color and background. She fills the whole
screen with crisscross lines. She is delighted with her visual
effects and, so, for that matter, am I.

*Rick, a third grader, was also on the computer for about 20
minutes. He continues in much the same vein as Jenny. After
5 minutes of playing around with filling the screen up and chang­ing colors, he changes what he is doing. He goes into the
Editor and writes out two procedures called BYE and QUE. I
notice his procedures include the REPEAT command, the use of
parentheses, and SETBG and SETPC commands. He types CTRL-C and
gets out of the Editor. He achieves much the same effects as
Jenny. He then decides to stop the execution of his procedures,
does not know how, looks at the Logo commands on the board, tries a few CTRL statements, and finally hits CTRL-G.

Both children achieved approximately the same result: brightly colored crisscross patterns that covered the screen. However, the procedures they used were different. Rick had discovered a more efficient way of doing what Jenny did. He had taken "a mind-sized bite of knowledge."

Play can be a prelude to problem solving. In fact, I noticed that children spend the first few minutes on the computer flexing their Logo skills, so to speak. While ten or even twenty-minute sessions are helpful in getting all children exposed to Logo, the period seems too short for the children to engage in any meaningful problem solving activity.

**PROBLEM SOLVING/GOAL DIRECTED LEARNING**

Goal directed behavior includes all instances in which the child knows what he wants to achieve or at least has some conception of what he wants to do. The child has some idea of what he wants to achieve, and uses the "models" of "bits of a model in his head" that he has learned from previous interactions. In the course of testing his "theory" or model, he may discover something totally new and change his original goal.

The following incidents contain elements of goal directed behavior as defined above:

*Steve, a second grader, is drawing something on the screen. The figure looks like a "T." Steve looks a little puzzled at the figure he has drawn. It is obvious that it is not quite what he wanted. He uses his hands and his body to figure out which way the turtle should turn. He appears to have made up his mind, but now wants to look at all his previous commands. He asks the teacher who happens to be standing nearby. She explains the commands CTRL-T and CTRL-S. He summons up all his text with the CTRL-T command. He tells me that he is trying to write APPLE II on the screen. His 15 minutes is up and the child who has come to replace him is getting restless.

*Dang, a fifth grader, starts by drawing a square. He then goes on to construct a three-dimensional figure, a cube. He debugs incorrect angles and has a perfect cross-sectional diagram. The teacher notices his work and commends him. She asks him to write out his procedures. I look at his procedures. He has only used FD, BK, LT, and RT commands, but he has used them in strings. I ask him what he would call his picture. He replies simply, "Boxes."

*Bao and Mike, two second graders, are sitting together by the computer. Mike has his turn for 15 minutes and then switches with Bao. Bao has his procedures written out on a scrap of paper. He has some difficulty in coordinating typing and looking at his paper. Mike offers to dictate to him. Bao's time is up before he has finished typing out his procedure.

*Two fourth graders, Danny and Hal, are at the computer for ten minutes. Only Danny gets a chance to type. He has a diary in
which he has some procedures written out. He has also saved some of his procedures on a disk. He uses the POTS command to look at the titles of his procedures. I notice the names of his programs: Doggy, Woodpecker, Pitfall, Monster, Kiss, and Mr. T. He calls up his Pitfall procedure, and makes a spelling mistake which his partner points out to him. He examines his procedures, and then tries to draw a heart (Valentine's is just a day away). His final product is almost perfect. Their time is up. He turns to me and tells me that the whole project took a couple of days.

The above sketches illustrate a range of problem solving behavior. Steve and Bao clearly had the germ of an idea in their heads. However, the short period of time allotted to them and their novice typing skills made it difficult for them to translate their ideas into procedures or programs that worked. Danny and Dang, on the other hand, were able to extract the maximum mileage out of the same amount of time. The latter, however, are more likely to represent the exception than the rule. Dang's case is particularly illustrative of the power of Logo as a heuristic device. He used what he knew about squares to construct a cube. His transition from plane to solid geometry was natural and logical. He had moved to a domain of math 11-year-olds are not supposed to know much about. To him, his cross-sectional diagram was simply the "boxes" he wanted to draw.

To conclude, I should like to reiterate a point made earlier. This report does not attempt to provide definitive answers. Rather, it provides tantalizing glimpses of children's behavior at work and play on computers. Many questions remain unanswered or only partially answered: Does Logo impact on learning? Does Logo affect traditional classroom environments? A colleague's comment is relevant here. She remarked that a year ago it would have been inconceivable for a child to remove himself from a lesson and do something quite different in a corner of the classroom. Logo has made that possible.

Reported by Asha Rangan

University of Minnesota
March 31, 1983
I. DARIUS

Darius entered first grade hesitantly. In fact, he did everything slowly and hesitantly. He never talked aloud and only whispered his most urgent messages. He had been placed, as a kindergartener, in a "Socialization Group" to try to draw him out of his shell. Darius watched everything from behind the quiet dark eyes. He is very much a child of the Indian culture.

Darius' mother is in her twenties, a single parent who obviously loves her son. She operates a word processor for a law firm. Mother and son live in a run-down eight-plex.

Darius was initially working in the middle reading group. He was slow to complete the required seatwork and needed prompting to finish. Mostly, he just sat and watched. Yet, it was apparent that he was beginning to learn to read.

The computer arrived in the classroom the week of Thanksgiving. Darius was absent that week and missed the introduction and rudimentary instruction given on its operation. Another child was Darius' guide into computerland. With this direction Darius began his transformation. He spent nearly 1-1/2 hours at the computer his initial time.

First, he was noticed to be completing seatwork without prompting. When finished, he would slide his chair over, next to the child at the computer and just watch. (Darius' desk is located five feet from the computer table.) He next was observed to be standing beside the Apple II, actually talking and making suggestions to classmates. When others had difficulties making the computer perform, Darius was quick to show them the solution. Then others started going to him to get help with LOGO.

In summary, Darius moved up to the high reading group -- to the top of it, in fact -- skipping entirely the Level 4 (third) preprimer. He now reads second grade books with ease and completes assigned work -- over twice as much as previously done -- each day.

He is very quick and accurate at arithmetic. He participates during whole class discussions and even voluntarily participates during Monday morning "Sharing Time." He possesses a large fund of general knowledge. His hand now shoots up like lightning when he wants to be called upon during class.

The topper occurred about three weeks ago when I sat him on a chair for a ten-minute "time out" because he wouldn't stop talking!
Now Darius is "one of the boys" -- as playful as any other 6-1/2 year old and even gets into minor mischief with his pals.

His mother and I both believe the computer, with its LOGO language, had a great deal to do with Darius' metamorphosis.

Darius was one of the three little boys who discovered how to make a square in LOGO one morning. By lunch time, they had taught six others to draw squares. Darius simply gravitates toward the computer at all times.

The smiling, confident, yet still basically quiet child, of April scarcely resembles the silent, watchful shadow of November.

Postcript: Darius also attended the after-school computer classes held at Monroe. He said he preferred LOGO to BASIC which was the language used there.

II. ALEX

Alex brought birthday treats the first Friday in September. He is the oldest child in the classroom except for one that had been retained as a kindergartener.

Alex worked swiftly in arithmetic. He had much to tell in social studies discussions and he loved science. He just couldn't read. In fact, he became very nervous and would shift his weight and wring his hands when reading was expected. At all other times, he had an easy smile and radiated confidence.

The fall conference with Alex's mother had her near tears as I told her that we should begin a special education referral for Alex. Nothing I tried had reached the child. He seemed to learn neither sight vocabulary nor phonetic sound-symbol relationships. All my own training as an SLBP teacher seemed not to be enough to start this boy to read. Title I supplementary instruction was also not getting the breakthrough.

Then at Thanksgiving the computer arrived in the classroom. Alex quickly understood how the Turtle graphics worked. He easily became the room leader in operating the computer.

Alex would arrive at school 35 minutes early in the morning and stand and watch a sixth grader who worked on the machine before school each day. This seemed to be a stimulus in that Alex was the first person to draw a picture, versus creating wrap-around multicolored designs, a stage he also passed through.
Concurrent with the computer's arrival and Alex's attention to it, he began to read. It was mid-January when I realized that Alex was beginning to sound out words!

When the SLBP evaluation was completed in early March, it showed Alex to be at second grade level in arithmetic and at first grade level in reading. He was not eligible for SLBP! A WISC showed him to be at IQ 113 -- definitely not the slow child he appeared to be in kindergarten.

While he is still in the low reading group, he is at the top of it and is steadily progressing. I am considering having him work with the middle group also in hopes of having him move up to that faster-paced instructional group.

I firmly believe that Alex's positive experiences with LOGO programming influenced his receptiveness toward reading instruction.

Incidentally, Alex also attended the after-school computer classes in BASIC. He quit after four weeks, pronouncing them boring. Yet he has a nearly two-hour attention span on LOGO, just doing his own thing.

III. MARIE

Marie's mother told me at spring conference time (March 7) that she believes that the computer had something to do with Marie's reading.

As she put it, "Before the computer, I would each night sit with Marie and tell her the words on her nightly homework sheet. After the computer had been in the classroom about six weeks, Marie began to tell me her homework words, and she was done in five minutes." According to her mother, Marie had shown no interest whatsoever in reading until the advent of the computer. Marie also attended the after-school computer classes.

This parent stated that the family will be getting a computer as a family present next Christmas. She sees it as a very positive influence.

Marie is grouped with my middle students for reading instruction. She is quiet and shy.
IV. A 7/8TH GRADE CLASSROOM

The same students are in the room for the morning block (9-11) and the afternoon block (1-2:30). Reading, language, literature and social studies are the subjects being taught. These are a few comments from my journal about the group.

**November:** Tim has come 45 minutes early every day so far. He and I practice our skills together; he's taken over the role of instructing the class. Everyone is talking about the machine. I'm very surprised at how well people work together and TALK. Instituted a sign-up sheet where two students work for a 30-minute block.

**December:** Tim and John still coming early. "Out of space" is a familiar message -- that means shutting off the computer and loading up again. Students vary in skills. Jim and Christine will not sign up for computer. I have not made them. Students spend a lot of time watching other people's programs. Most programs are named with student names and consist of color and FD 9999.

**January:** Will they ever do anything besides create lines to cover the screen and flash random colors? Repeat 9999 (FD 8 RT 8 FD 8 . . .) They create page-long programs of nothing but lines. I learned the ERALL function for handling "Out of Space." I feel dumb about that one.

**February:** Had two computers for two weeks. It made a real difference. We advanced away from the lines as a class. What a relief!!! Why couldn't we always have two computers? Even the kids commented how much better it was.

**March:** Changed the sign-up to 15-minute blocks individually. I noticed that when they were together they didn't do as much, at their current ability level. When alone they will work for a longer period of time on their own project. Students name programs by function instead of by their own name. (Example: door, sun, wheel, limb, etc.)

These are a few comments I had written in my diary. I've got many more but it would be impossible to relay everything on paper.

Rhonda Simonson
7/8th Grade Teacher
Monroe Community School
Two weeks before Spring Break I was notified by my principal, Peter Grams, that I would be receiving a new student. This young man was being removed from his home school because of behavioral problems, both with staff and peers.

This student was both apprehensive and defensive upon arrival at school. As the week progressed, he withdrew into himself and was quite belligerent to all around him.

On Wednesday of that week he came to me freely and asked when he would be scheduled for computer time. This was the first statement he made to me freely, without being pried. I stated that I had scheduled him for Friday. I also stated that I had asked a peer to present the initial LOGO commands to him. I chose this particular student because these two had already had two quite serious confrontations. (I enjoy taking the bull by the horns.)

Friday came and the appointed time was reached. The two young men sat down. I must say I kept a bit of "close," but not obvious, eye on the two of them. In the beginning the tension was very noticeable. However, after that turtle appeared, communication began, and from that point on it was a continuous "give and take" between the two. I had purposely scheduled Randy's (new student) time directly before Tom's. Tom came to me and asked if it would be OK if Randy could share his time with him. The ice was broken -- a common interest was struck between the two.

I cannot say that everything has continued "rosey." Not all problems have been solved for Randy by LOGO. However, I know Randy's reaction and my class's reaction to LOGO. I ask that you visit my room sometime when Randy is working on the computer. Watch his face; his eyes. Watch him literally jump in his chair with excitement. Watch him figure out programs in his notebook, and the intense concentration when he tries. Yes, he has seen failure, but he keeps trying -- not so in long division. And success -- watch his face when this occurs. Bring a camera, take a picture and enlarge it. Mount it at a School Board meeting. How could we be turned down for monies needed to keep this program going!

I grant you, I am probably more interested in the affective aspects of teaching than the average teacher. However, I see LOGO as not only a technological tool, a tool for reasoning, and a tool for logic, I see it as a tool that has enhanced sharing, not only within the classroom, but also among the staff. I see it as excitement, as challenging, and a tool that even a low ability student feels success with. It helps build self image, and this carries over to other parts of the curriculum.

I could write so much more, but my papers call me that must be graded and lessons that must be planned. Someday give me a couple of hours to speak about LOGO, and I promise all will become as excited and as enthused as I, maybe.

I am sorry about the poor sentence structure. I am doing this from my heart -- not for a grade in English.

Judith Ronnel
5th Grade Teacher
Mann School
THE INDEPENDENT CHALLENGE

TEACHER

The year spent learning LOGO and working with students and LOGO has been the most exciting teaching experience I have had. As a non-tech person, working a Mixmaster was a major project. I now find myself reading articles I would have passed, listening to lecturers, commentators, experts in areas heretofore totally remote and totally ignored. My family shares my enthusiasm and has broadened its own horizons. I have changed; I will never "not" be a LOGO person.

STUDENT

Enough for me. My observations regarding students: In most cases, the students I had worked with prior to LOGO were consistent. The ones I expected to be turned on by LOGO, were. However, I had some super surprises. Some of the slower students did remarkably well and blossomed. Students, some unknown to me by name, from two other classes, found their way to my room and LOGO, and used the editor to prove to themselves and to their teachers that they, in fact, could write and read, but more importantly, think!

An anecdote to remember: The librarians told me that one of the disruptive students had returned overdue library magazines because he wanted his report card. He had had the books all year and previously showed no interest in obtaining his grades. However, this semester, after using LOGO to write personal essays, some most profound and shared with his two teachers, he was receiving two B's and he really wanted that report card. The teachers had credited him with his LOGO work.

Generally speaking, the students who spent lunch time and after-school time with LOGO made the most gains. Time was really the essential ingredient.

SCHOOL

Structural change. Two, no three, other teachers utilized the LOGO experience for their students and gave them credit for their accomplishments. It shall continue!!

In general, as a speech and language clinician, I found the use of the computer most effective in managing individual programs for students. For example, Ai-ling needed certain sound combinations for speech. She didn't know the "ch" words that are pronounced "k" or "sh." Meredith needed "st" words, multisyllabic words, and "ch" words that are pronounced "k." These are just a few examples. I have written programs for the specific problems, and the students have written their own programs for other practice drills. The most charming was the use of lists within lists showing how to analyze a word, and even showing the stress pattern for speech practice, on their own, without "the teacher." The independent challenge to find new words that are troublesome has created excitement. Several students have called me on the telephone -- no easy task for hearing impaired students to perform -- to have me listen to the pronunciation of their new words in sentences.

Vocabulary has taken on a new dimension. Now it is, "Hurray, learn the words so I can say them, and write sentences on the computer, and of course, say them perfectly."

I have thrown out my pages and pages of papers with lists of specific words and pronunciation diagrams. Now, it's all on each student's disk! What a bonanza!

Barbara Winthrop
Speech Clinician-Hearing Impaired
Highland Secondary Complex
What Can a Computer Do?

A computer can help people with their work. It can say, "Hello," and it can copy the Mona Lisa. A computer can make circles, squares, triangles -- all sorts of things. It can keep track of time. It can win games you can't. It can make designs. It can make millions and millions of lines, if you program it to do it, but if you don't program it to do that, it won't. We love computers!

Dameon Dombrook, Sarah McCormick, Matt Rosenberg, and Jason Welles
Groveland Park, Grade 2

What Can't a Computer Do?

A computer can't think. It can't do things by itself. A computer can't take your dog for a walk or give you a hug and a kiss and tuck you in bed. A computer can't give you a Christmas present, take out the garbage, or clean out the cat's litter box. A computer can't jump the Empire State Building, take a bath, or wash its face. A computer can't go swimming or bowling or read a book. A computer doesn't have any feelings. It's not unique, like we are.

Dameon Dombrook, Josh Enerson, Eric Jackson, Katie Mackenzie, and Sarah McCormick
Groveland Park, Grade 2

Katie Mackenzie
Groveland Park, Grade 2
LOGO has been a learning adventure for the intensive general learning difficulties seventh and eighth grade students we serve at Monroe.

The students enjoy working on the computer. They enjoy the challenges of getting the turtle to do what they want it to do. Many students have commented on how "dumb the computer is" -- that they have to teach it how to do everything. They also delight in their teacher making a mistake! The fact that everyone makes some mistakes coupled with their frequent success at getting the computer to do what they want it to has created a positive and exciting learning atmosphere. A new medium of learning has generated new interest and created new "stars." Now at least part of the school day is fun.

As a teacher working with the I.G.L.D. program one has the opportunity to see learning in "slow motion." Because our students learn at a somewhat slower rate, we have the chance to see more clearly how concepts are acquired. With LOGO there seems to be a natural progression from simply making the turtle move to making patterns and shapes. These shapes are then used in combinations to form complex designs. LOGO appears so logical in design that "recursive thinking" emerges from day to day interactions with the computer. While our students have yet to create graphic masterpieces, they are learning to think. LOGO motivates kids to develop problem solving strategies. Frequent success builds self confidence.

We have used LOGO for reading and math applications as well as the graphic mode. LOGO has been useful in creating spelling and reading work which is age appropriate, timely, and at an instructional level for our students. Class work can be done on the computer individually or in small groups. Individual assignments can be printed out for homework. Although the LOGO editor was not designed as a word processor, it can be used successfully with students working on sentence structure, spelling, choosing correct tense or adding appropriate endings to words. The students also enjoy writing group stories in which everyone contributes a sentence or two on a given topic.

In math the computer is used largely for making graphic design projects. The children draw their designs on graph paper, write out the computer commands required, type the commands into the computer -- then most importantly -- get the bugs out. The kids work out the distances and angles largely through trial and error, discovering some new applications of math. LOGO brings math to life, it is no longer a rote exercise, but something fun and useful.

An unexpected benefit of LOGO has been an increase in social interaction between students. The kids are interested in what others are doing, they have questions and often suggestions. LOGO gives the children something to talk about -- a new common ground. This is also true when regular education and T.E.S.A. students come to share our computer.

In summary, LOGO has been useful in many ways. It has helped students: (1) follow directions, written as well as spoken; (2) act in correct sequence; (3) attend to and improve spelling; (4) learn keyboarding skills; (5) develop problem solving skills (even thinking through which way to turn the turtle calls for a basic strategy); (6) the editor used as a word processor helps students improve their writing skills; (7) LOGO encourages appropriate social interactions between students.

Michael Hopkins
IGLD Teacher, Grades 7-8
Monroe Community School
This report concerns the Logo computer project in the St. Paul Public Schools for 1982-83. Roughly 700 students in grades K-12 were consistently exposed to access to the Logo computer, although for most students for most of the school year this access was limited to half an hour to forty minutes per week. It is all the more striking, considering this limited access, that the Logo teachers report an extremely high level of enthusiasm for Logo in their students.

In a fundamental way, this enthusiasm is the chief finding of this report: according to the teachers, Logo reduces boredom and disaffection in the public school classroom, frustrates students in a healthy, challenging way, engages students in a thinking-through process of creating and modifying intellectual products, and provides students with a classroom process with which they have strong emotional ties.

There are a range of other effects as well, reported more or less consistently across classrooms and teachers, and included in this report. This year's project was directed towards exploring issues surrounding teachers, and the majority of this report concerns teacher issues, rather than user issues. Still it is exceptionally apparent that Logo primarily affects students, and in a positive way.

Omissions in this report are the fault of the researcher; special thanks are in order for the teachers who patiently participated in the research process.

The investigation into the effects of using the Logo computer language in an institutional setting involves consideration of a number of different tiers or levels of analysis. These tiers range from effects on the individual user's cognitive development and behavior to questions concerning the effective management in a school system of the innovation and diffusion of a new educational technology. The levels of analysis considered in this paper are:

1. individual cognitive development and behavioral effects
2. peer socialization
3. individual student-teacher interaction
4. the classroom environment
5. Logo networks among teachers
6. administration and management of the Logo project

Findings in this report are the culmination of a limited amount (approximately 60 hours) of non-participant classroom observation; in depth interviews with the teachers participating in the project; and from data collected from a teacher survey of sociometric patterns and Logo usage in the classroom. Copies of the interview schedule and survey questionnaire are available on request.
Individual Cognitive Development.

Logo might be operationally defined as a problem-solving process whereby students define an initial goal or problem and pursue the step by step resolution of that problem. Quite often the initial problem is abandoned or completely redefined, and sometimes the sequence of steps in resolution may seem more or less random. But overall, students (or Logo users) seem amazingly willing to commit themselves to the interactive process of building and modifying programs of graphic displays. Still more amazing is the very high probability that this commitment or process is essentially undefinable, at least at present. It's not at all clear what students are doing when they're at the computer. It is clear that, by and large, they are engaged, and very often excited or happy, and that for the most part they are very willing to share what they create or discover. Some teachers describe Logo as a process of learning about thinking, not unlike drill and practice, and not unlike training in the fine arts or physical sciences. Some discipline and patience are acquired in using Logo, and intuitive notions about cause and effect, and some understanding of spatial or quantitative relationships. These properties probably suggest that both the problem in defining Logo (and its effects), and students' highly enthusiastic response to Logo, may come about because Logo teaches a process, and products are clearly of secondary importance.

Traditional public school classrooms are largely product-oriented, and stratification in the classroom is largely based on differential skill levels related to product display. Logo appears not to be a "content area", and if it affects other areas of cognitive development or expertise, those areas are likely to be process, rather than product, related. This is reinforced by the fact that teachers are generally agreed that "transfer" in the usual sense of the term doesn't happen. On the other hand, self esteem and transfer as linked concepts may be closely tied. Using Logo is synonymous with trial and error exploration. Although problems are idiosyncratic to each student, the process of solving a problem is consistent, and this consistency of process seems to be strongly reinforcing to the student, regardless of age or skill level. Many teachers felt that the direct reinforcement in a trial and error process, for a problem the student had some personal investment in, probably fostered a sense of control and self-esteem in the Logo user. It might be hypothesized that this higher self-esteem or a higher confidence in working out solutions to broadly defined or ambiguously defined goals or problems, in turn generated problem solving confidence in non-Logo areas.

On the basic skill level, there is certainly preliminary evidence that the Logo experience provides a trigger for "marginal" individuals, or those students who may not have made a successful transition into the social structure of the classroom - that is, a long-term group context with behavioral as well as intellectual rules and a status hierarchy, where evaluation of the individual is roughly constant and individualism and self-motivation (in general) are primary values. Many of the 23 teachers interviewed reported significant advances in demonstrated skill capacity for some students in their classrooms. The skill "breakthroughs" included striking advances in reading level, math ability, writing, and other basic intellectual and social skills. These highly visible "products", however, are more the exception than the rule, and it seems much more likely that an intermediate effect (or product), for most students, is an increased confidence in their ability to define and carry out the process of creating and modifying personally meaningful intellectual structures.
A vast majority of the teachers indicated that access to the Logo computer is a very strong motivational factor relative to general classroom behavior. Most reported that they were very hesitant to use the computer as leverage in effecting behavioral change, but indicated nevertheless that there was a spontaneous response to the highly valued time on the computer: students generally considered to be behavior problems clearly were willing to change their general deportment in order to not be excluded from access to Logo. In addition, sharing behaviors were reported as strikingly in evidence across almost all classrooms, and teachers consistently noted/acknowledged the "adult" nature of interactions among students in Logo-related activities. In particular, several teachers reported independently that students would treat each other as consultants, discussing parts of a problem they were working on, and comparing their respective experiences with adult concern and something akin to professional respect. It should be noted also that this phenomenon was found irrespective of the students' "stages" in school—contrary to expressed expectations by teachers that what goes on at the primary level probably does not overlap with the Logo experience at the secondary level.

2. Peer socialization.

One of the striking departures found in this year's institutional application of the Logo experience from earlier reports of laboratory settings is the absence of Logo undergrounds, networks of Logo users which develop spontaneously as a sort of group problem-solving context. Teachers in the St. Paul sample uniformly reported the absence of Logo elites or sub-groups in their classrooms, but reported instead a very general and widespread tendency among students to share their accumulated knowledges, and to spread their enthusiasm about Logo to non-Logo classrooms or students.

One of the consequences of introducing Logo into the public school classroom most respected by teachers is the almost universal phenomenon of students teaching other students. Most teachers emphatically do not teach Logo, either as a skill or as a content area. Parenthetically, most reported some frustration in two areas: not being able to teach new Logo material more effectively, and having trouble finding and taking advantage of the "teachable moment", that student-teacher interaction that establishes a particular direction for the student, or capitalizes on an idiosyncratic problem-solving situation generated by the student's initiative.

On the other hand, the phenomenon of peer socialization into the Logo experience may be one of the possessive project's strongest assets. Students have notoriously little power relative to the teaching agenda of the classroom, but in socializing one another about Logo, two things probably happen: first, the students teaching other students have to clarify their own (probably inarticulate) thought processes and problem-solving skills; and second, the students collectively generate a "system of knowledge" that is not foreordained by adults. A significant by-product of this second phenomenon is that the usual power differential between adults and children in the classroom can be occasionally relaxed: adults clearly value the knowledge generated by the student users, and very often students are called upon to explain or teach their skills to adults and others in the classroom, for a brief time redefining the concept of "peer" to include the interested Logo teacher.
3. Individual student-teacher interaction.

The public school teachers represented in this group of Logo teachers appear to be caught in an extremely untenable position: the "public" goal of public school education has to do with the inculcation of intellectual competence and a mastery of a group of highly articulated basic intellectual skills. The "private" goal of the classroom, however, independently reported by individual teachers in this year's project, has as much to do with establishing psychological competence in students and the mastery of a group of basic social skills as it does with fostering intellectual expertise.

The conflict between the public and private goals appears to be a major source of exhaustion or teacher burnout, and a central, defining factor in the character or quality of student-teacher interaction in this sample of public school classrooms. It should be noted in passing that teachers are not generally professionally trained to handle this "private" agenda; but as the proportion of school age students enrolled in public schools decreased (and private school enrollments increase), the population of students determining the classroom's goals along (remedial) psychological and social skills lines must ultimately have its impact on intellectual skill mastery.

It is relative to this public/private goal conflict that Logo may establish its principal benefit in an institutional setting. If the tenor of the classroom is largely determined along the "private" goal lines, and crowding in the classroom stays at current levels, it is virtually impossible for teachers to provide consistent, high quality feedback to each of their students about the student's progress, skill levels, intellectual competence, etc. The Logo interaction, however, provides a student with direct, consistent high quality information about intellectual processes, and even more important, does so relative to a problem generated by the student. This kind of interactive feedback, where the computer is differentially responsive to the idiosyncratic needs/skill levels of individual students' intellectual demands, may in the long run counterbalance the remedial nature of the psychological and social skills agenda of the classroom.

4. Classroom environment.

The effect of Logo on "classroom environment", rather amorphously defined, was a central concern of this year's project and of this needs-assessment research. The classroom environment can be more or less abstractly conceived. At the most abstract, the classroom is a set of resources and resource users, and environment is qualified by the nature of resources and the degree of access or pattern of resource distribution among users. From this perspective, Logo might be expected to effect a radical change in classroom environment, since by general agreement it is a resource both highly valued by students (and thus highly motivating) and, by design, equalitarian in accessibility. At the most concrete level, classroom environment is the exercise of authoritarian privilege by a teacher with a well-defined view of human nature, and, from this perspective, expectations for Logo effects must be mediated by the categorical view of human nature an individual teacher holds.
This is true in the sense that a teacher's authority defines both a formal and an informal agenda for the classroom. In many ways, the formal agenda has to do with the "public" goals mentioned above, but the informal agenda has to do with how day to day classroom affairs will be conducted. Teachers with different informal agendas have different expectations of their students, make different attributions about their students, and define and exercise authority in the classroom in different ways. Two very important informal agendas, reflecting essentially different views of human nature, were apparent in this year's sample of Logo teachers, and the defining contrast between the two concerned the extent to which outside influences, including the teacher and classroom resources like Logo, can actually impact on the global personality characteristics of the student. In short, in some classrooms the student's characteristics are taken as given or fixed, while in others the student is seen as another classroom resource, unlikely to affect students in an important or substantive way, or it can be seen as a potentially high-impact classroom variable. In either case, the role of the teacher in defining either of these expectations about Logo, and its place or function in the classroom environment, cannot be underestimated. At some point in the research into Logo's effects, the informal agendas of teachers will have to be systematically taken into account.

Parenthetically, Logo has the potential to decentralize some aspects of the teacher's authority in the classroom, and with some teachers this may be less acceptable than for others. In most classrooms, after one school year students have spent far more time (even with limited access) working with Logo than the teachers have. Questions about Logo usage and problem-solving are often directed to other students, rather than to the teacher, and this type of phenomenon may be construed positively or negatively, depending on the teacher's perspective.

An interesting paradox about Logo is that, although it clearly disrupts classroom activities, it is not seen as a disruptive influence by the vast majority of teachers. Generally, students in the Logo classrooms are on the computers for a very high proportion of class time, and with a high turnover rate at the computers. In addition, most teachers accept questions (and thus interruptions) about Logo problems from students on the computer while the teacher is engaged in another, non-Logo classroom activity. Despite the crowded, relatively high stress conditions of the Logo classroom, Logo reportedly enhanced classroom environment, primarily because teachers valued the high level of enthusiasm that the computers generated. Further, a number of teachers reported that introducing Logo to their classrooms revitalized the teacher's own enthusiasm for teaching and provided a much needed antidote to burnout.

Finally, there is some suggestion in this year's data that the optimum number of computers in the Logo classroom may not be one computer per student, or even a rough approximation of this ideal, at least as long as the traditional classroom emphasizes content-specific learning. Logo operations in the 26 classrooms were on the whole social cooperation enterprises, with some variation on the theme. Teachers often remarked that the Logo computer's primary advantage over other classroom resources in commanding students' collective interest was graphic visibility. (The second most valued function or
characteristic was ease of editing.) To a large extent, the collective enterprise aspect of Logo seems to mediate against forces of isolation and stratification in the classroom, and this may be a subtle but not insignificant phenomenon, and one that mitigates against using Logo in a non-regular classroom, laboratory setting. However, this effect, if real, has not been formally recognized as an outcome of Logo implementation, and such an effect might not be universally accepted as valuable even if acknowledged.

This means, among other things, that teachers and Logo administrators need a flexible, effective communication structure or format within which to work out basic agreements about Logo's defining characteristics, especially as they emerge in the institutional context of the St. Paul schools. An aspect of innovation and diffusion that seems to have been overlooked in this year's project is just this basic process of formulating shared meanings or shared definitions. This should be a very high priority for Logo's second year.

5. Logo networks among teachers.

The single most glaring deficiency in the Logo project was the extent to which teacher experiences across classrooms and the teachers themselves remained uncollected and unorganized after more than six months of experimentation. Most teachers were very enthusiastic about having Logo in their classrooms, despite the extra work involves, and most reported that the Logo experience was, in general, beneficial for their students. Further, the teachers were clearly in consensus that a large part of the students' benefit derived from the social aspects of Logo, including but not limited to experiences in group problem solving, extensive sharing behaviors, social acclaim by peers, and social acknowledgement of expertise or ingenuity.

That these experiences were natural, expected parts of the students' Logo experiences only heightens the degree to which these elements were not part of the teacher's Logo experience. That is, what was either provided, facilitated, or acknowledged as a natural experience for children was nowhere provided, facilitated, or acknowledged as natural or beneficial for the adult teachers. There was little or no opportunity in this year's project for teacher's group problem solving relative to either learning or teaching Logo; remarkably little information about teaching experiences was shared between classrooms, especially across schools; there was not social acclaim or acknowledgement emergent among the teachers, and in fact, to the contrary, there was a fair amount of evidence of rivalry rather than solidarity.

This must be acknowledged as an exceptional finding for two reasons. First, the Logo teachers were a distinctive group within each of their respective schools, and the distinctiveness was not always a social advantage. One might expect the Logo teachers to develop a group cohesiveness in response to criticism or sanction from non-Logo personnel. Second, and more striking, the Logo teachers in fact constitute a unique group, in several respects. They are the first institutional users of a radical computing technology. They are a group experimenting with at least a moderately radical instructional philosophy in traditional public school classrooms, emphasizing process over product. Their classrooms represent a sizeable cross-section of the real-life problems confronting urban educators in the United States today, and special
education issues, broadly construed, constitute a significant proportion of those problems. Finally, the group may be unique historically, from the vantage point of educational technology, public school education, and educational innovation. There is literally no evidence that this year's teachers see themselves as such a unique group, along any of the above dimensions. This point is the more exceptional considering that the focus of this year's project was Logo teachers, rather than Logo students.

The plight of the urban public school educator has been substantially documented for at least 20 years. Rewards for teaching are primarily psychological, rather than financial. Teaching involves "intensive and virtually continuous interaction with multiple clients (students) with virtual isolation from peers and other adults. Classrooms are crowded places with lots of talk ... (but) at the same time, teaching is lonely work compared to occupations with peer work groups and highly developed networks of collegial relationships."*

If Logo is to be an exceptional educational innovation, it is imperative that Logo teachers see themselves as an exceptional group, with shared interpretations of their common experiences, and some shared valuations of the project as a whole. This can only come about, however, if external supports can be generated to offset teacher isolation and lack of tangible rewards.

6. Administration and management of the project.

One of the principal benefits (and responsibilities) of management is the definition of goals for an organization. Through the process of defining goals, an identity for the organization is established. Organizational purposes and organizational identities or self-definitions are thus very strongly linked. The theory behind Logo has a limited history, scope, and development since it is largely one person's work, but it is not ambiguous, for its limited development. Logo is unequivocally a process of students' creating and modifying (intellectual) structures. Its powerful attraction to most students is that the structures they produce are personal, highly visible, and easily modified. The process of modifying intellectual structures, especially in a non-threatening or "secure space" context, is certainly a competitive model for the process of intellectual growth and development. Competence in intellectual flexibility, in the process of making and remaking, creating and adapting intellectual structures, preferably with ease and speed is what Logo is about. Papert's central thesis is that "(learning) anything is easy if you can assimilate it to your collection of models" - and Logo is clearly an exercise program in generating and then expanding variations on interesting models, or intellectual structures.

One of the things that Logo is not, and was not designed to be, is training in computer programming. Nor was it intended to be an easy "introduction to computers." And yet, with remarkable consistency, teachers (and students) failed to clearly define the nature and purpose of Logo's fairly explicitly functions. This is a management failure, and may represent a politically expedient, and organizationally divisive, response to the inherent problems of educational innovation and diffusion in an urban public school system. So long as Logo's function in the classroom is undefined, so will the project as an organization remain undefined, and from at least one perspective that may enhance its probability of survival. On the other hand, the longer the project's goals remain diffuse, the more unlikely it is that Logo teachers will constitute any kind of cohesive group, or develop more than a nominal commitment to the project. When, at some point, Logo has to compete with alternative innovations, or basic programs, and no clearly defined criteria for its success have been established, and no bloc of teachers is cohesive enough to negotiate on its behalf, Logo will clearly be expendable, to the utter frustration of those teachers (a majority of this year's group) who found it effective in their classrooms. A management priority must be to strengthen the understanding and general commitment expressed by this year's teacher group. This should involve creating an information bank or network; facilitating communication among teachers across schools; alleviating the need for week-end meeting if at all possible; encouraging the development and acknowledgement of local expertise; expanding availability of "how-to" materials; and consideration of some sort of reward structure, potentially in the form of time off from teaching, rather than money.

Discussion/Conclusion.

As long as teacher's do not have to communicate (and effectively agree) on basic definitions and thereby establish a group commitment, the project will stay essentially a political exercise. Therefore the principal recommendation of this report is that the teachers be supported above all in this one area: that they be encouraged to produce working papers based on their collective experience, and that they be actively engaged and supported in documenting the expertise that they are accumulating. Second, that some formal mechanism be established for sharing information among teachers and for keeping records. Third, that a budget allocation be sought for hiring substitutes for Logo teachers, so that training sessions can be held during the week. Fourth, that more "how-to" information be systematically made available to teachers and that if at all possible a local "expert" or consultant be designated, preferably from among this year's group of teachers, with compensation for consulting time. This person should ideally have minimal political bias relative to Logo and should have high communication skills. Fifth, some attention should be directed toward defining the optimum number of computers for different kinds of classrooms, specifying how and why certain conditions are optimal, and why others are of marginal significance. This effort should then act to direct a purchasing and distribution policy relative to expanding this year's project. Sixth, that beyond the Logo project per se, the Community/School Collaborative be given the task of systematically assessing means of linking family and community social services to the public school.
population, with an initial goal of collecting confidential reports from teachers documenting the extent to which family and community stress variables impinge on performance in the public school classrooms in St. Paul.

Questions and comments about this report are welcomed by its author, who is solely responsible for its content. Address inquiries to:

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LOGO EFFECTS IN PUBLIC SCHOOL CLASSROOMS
Social and Environmental Considerations

Is LOGO universal in its effects? No. Is LOGO universal in access to its effects? Yes. If the effects are not universal, but access is, what is missing? The puzzle is solved within the environment of the classroom, within social determinants of achievement, not cognitive ones.

To change achievement, i.e., increase achievement, schools need to introduce something other than what is already required. A new reading series, for example, requires reading! We need to look for sharp intervention, a mediating force, one that does not require achievement but, rather, enhances it.

LOGO appears to enhance a group of status variables that are strong predictors of achievement. Improved achievement is more likely to occur at the lower end of the scale. Kids at the top already have their set of "gears" to work with. Kids at the bottom—who are not dumb—are still looking. The odds are that when they find their gears, the learning process will be strengthened.
During the 1982-83 school year, the Logo computer language and educational philosophy were introduced as a pilot project to a non-random sample of 26 classrooms in six public schools in the St. Paul, Minnesota school district. The classrooms ranged from K through 12 and included six special education classrooms at varied grade levels and with widely varying student populations. In the majority of mainstream classrooms, most students received an average of about 40 minutes per week in two sittings at the terminal, for most of the school year. Also in most classrooms, students would unobtrusively rotate turns at the computer while classroom instruction continued; students were responsible for any work missed while at the terminal. In June, 1983 teachers were asked to complete a rather extensive one-shot retrospective questionnaire in which they were to assess ordinal ranks for their students on a number of achievement and social status indicators, using the classroom population as the reference group. Sixteen teachers completed the questionnaires on 385 students, a sampling frame of about 50%. Inspection of the distributions, in the Logo sample, of six social status variables proposed in the literature as predictors of academic achievement suggests a strongly representative subset of the total user population and in fact of the six school populations in general. The goals of the questionnaire were to: (1) appraise the universality and overall strength of a generalized impact of Logo usage on students' learning capacities or abilities; (2) to assess the relationship of improvement in learning capacity to the achievement predictor variables; and (3) to characterize the subgroup of students who were deemed most affected by the introduction of Logo to their classroom environment.

Twenty-four of the twenty-six teachers also participated in in-depth interviews at the end of the school year. It should be noted that, in addition to the quantitative results related to achievement and social stratification in the classroom reported below, a number of key qualitative results emerged from the teacher interviews. Among these are: (1) Logo may be utilized as a diagnostic tool in cases of both physical and cognitive impairment. It was used successfully in this manner with senior high school stroke victims. (2) Teachers as a group credited Logo with rejuvenating their commitment to teaching. (3) The Logo computer is compatible with classroom environments of extreme diversity. It is literally adaptable to the K-12 spectrum and to a wide range of instructional philosophies. Finally, (4) it excites and motivates children across grade levels, beyond the expectations of the most skeptical of teachers.

A social stratification approach was taken in the 1983 St. Paul data collection; that is, the research was concerned with the general concept of equal opportunity to perform and succeed in the classroom and how Logo might affect this, as well as investigating the relationship between exposure to Logo and academic achievement. The research hypotheses were:
1. Logo positively affects perceived or assessed learning ability in the public school classroom;

2. these positive effects will be differential for students based on selected complexes of social characteristics but not on achievement characteristics;

3. the effects will not be stratified by gender or grade level, but

4. will be inversely related to perceived opportunity to achieve and to classroom type, where classrooms are distinguished by instructional and socialization agendas.

A brief summary of the research findings follows, in order of the hypothesis stated. (1) Forty-nine percent of the students in the Logo sample were thought by their teachers to have improved learning abilities as a result of working with Logo. Ten percent of the sample were assessed as very clearly improved, a rather remarkable finding considering that the average exposure to Logo over the school year amounted to less than 40 hours total per student. (2) A profile of the very clearly improved group indicates that students who respond strongly to Logo may, as a group, have certain definable characteristics: they are more frequent initiators of contact with their teachers; they are more likely to be independent and a little disruptive in the classroom; they are much more likely to be loners or social isolates, and they are much more likely, on the average, to be students whose educational achievement will be inhibited by factors other than their basic potential. These results suggest that Logo may present an opportunity to a group of traditional underachievers who are "disguised" in the classroom as social isolates.

A systematic appraisal of the relationship of improvement in learning abilities and the social and learning characteristics of students in these public school classrooms revealed (3): that improvement is not dependent (statistically) on achievement rank - students from all achievement quintiles have the opportunity to derive improved learning capacities by working with Logo. Improvement is also statistically independent of grade level and gender: both males and females benefit, including when controlled for other factors such as achievement level; and Logo appears to structure an opportunity for learning improvement across both the mainstream and special education, and primary and secondary spectrums.

However, (4) when classrooms are categorized by type of educational or instructional agenda - that is, whether the basic problem facing the teacher is to raise the mean level of achievement scores or reduce variability in the range of achievement levels, or both, improvement is modestly and inversely related to type of classroom: students most likely to benefit from Logo are those in classrooms with the most difficult instructional agendas, where the teacher must simultaneously attempt to significantly raise the average level of achievement and reduce variability in student achievement scores.

Likewise, when classrooms are categorized by the social background and learning characteristics of their students, improvement with Logo is statistically most likely to occur in those classrooms with the most difficult
socialization or organizational agendas: motivating and teaching students who, as a group, are below the population average on both background and motivational dimensions.

Finally, it should be noted that none of the individual social status variables among Logo users are statistically significant in this data as predictors of improvement in learning ability, and yet these same status variables are all highly significant indicators of achievement, both in this data and in the literature. This strongly reinforces a basic supposition about Logo: that its effects are available to any user. This analysis is corroborated by the researcher's efforts to find any evidence to the contrary, statistical or substantive, in the 1983 pilot study. No evidence of differential access to Logo benefits emerged from the analysis. While it is unrealistic to assume that Logo will have a universally salutary effect in the classroom, the effects - when sufficiently refined conceptually and empirically - can be expected to occur regardless of the cognitive or social characteristics of the user. Our data further suggests that the learning environment of the classroom mediates Logo effects, and a tentative conclusion is that public school classrooms structurally disadvantaged in terms of both instructional and socialization agendas may be the greatest beneficiaries when educational achievement is the outcome variable.

Statistical assertions in this paper are based on significance levels more stringent than .05; measures of association and tables of frequency distributions and relationships referenced in this report are available in a longer paper, upon request of the author: Peter Fire Dog University of Minnesota Department of Sociology 1109 Social Sciences Tower 267 19th Avenue South Minneapolis, Minnesota 55455
The 1983-84 evaluation of the Logo computer language and educational philosophy in the St. Paul Public Schools focused on five questions:

1. Do some students benefit more than others by using Logo? If yes, why?
2. What kind of effects are prevalent among students for whom effects are reported?
3. How consistent are these effects?
4. When do students respond to Logo, and with what intensity?
5. How does Logo fit into the process of achievement in public school classrooms?

Data for the project are based on assessments made by 29 Logo teachers on 620 students in January, 1984 and follow-up assessments made on 373 students in May, 1984. For these students, positive effects were reported for about 40%, and significant or dramatic improvements in learning capacities or abilities were reported for about 10%. Of the students in our sample, 47% were female; 37% came from lower or working class families; 19% were thought to be social isolates in the classroom; 22% were seen as having serious inhibitors to achievement, above and beyond their native achievement potential; and 61% were in the three lowest achievement quintiles. Eighty-four percent of the students reported on were in grades K-6. Overall, the sample represents a test of Logo's capabilities in a realistic cross-section of public school students.

The following summary comments are based on preliminary analysis of the data from both January and May, and on the characteristics of the sub-sample of students for whom we have data at both points in time.

1. The most important question in our research is whether or not students who are low achievers can be enhanced in their learning and classroom performance abilities as a result of working with Logo. Our tentative conclusion is that Logo does, in fact, intervene in the achievement process, and that many factors that are traditionally predictive of low achievement (disruptiveness, isolation in the classroom, emotional problems, etc.) have no influence on a student's ability to improve his/her academic performance as a result of working with Logo. These results confirm a preliminary finding in our 1982-83 pilot study of Logo effects. We would interpret these results to mean that access to Logo benefits is literally available to any student, regardless of their prior achievement background and regardless of the social characteristics that they bring to the classroom.

One of our most important findings in this year's data is that students with very limited cognitive styles—those students with limited capacities for solving or working with abstract problems—have just as much access to Logo benefits, or are as likely to show benefits from working with Logo, as
higher ability students. The most severely limited students in this regard constitute 11% of our sample; this presents a serious instructional problem for the public school teacher. The average achievement score for these students is 29.1, on a scale with a top achievement score of 100. Logo may be a significantly different educational tool for these students simply because it presents an opportunity for the students to systematically proceed from a fairly limited vantage point in working with abstract ideas and concepts to a more sophisticated level more in line with an average level of abilities in the classroom.

2. When students use Logo, what kinds of effects can be expected? The most frequently reported improvements in classroom performance or behavior were found in logic, structured thinking and planning; concentration, memory, following directions, excitement about learning; motivation to learn and pleasure in working; reading and reading comprehension; using quantitative relations and communications skills; and in a set of social variables that included increased interaction with peers, a sense of belonging and acceptance in the classroom, and a pronounced increase in sharing, consulting and teaching among students. All of these effects were reported as significant (not just minor or incidental) for more than 20% of the user group. In addition, a decrease in hyperactivity was reported as a major effect for 12% of all users; a decrease in absenteeism for 14%; and an increase in overall level of achievement for 18%. Homework and classroom assignments were clearly improved for 17% of all users; altruism and prosocial behavior for 19%; cooperation and classroom participation clearly improved for 24%.

3. It is important to consider Logo and its effects on student performance and achievement in the context of a set of educational processes designed to integrate students into a successful long term educational or learning career. Among the other major influences of student growth and change in the classroom that our research took into account were: tracking or ability grouping, simple growth or maturation in the student, the personal or mentoring influence of the teacher, the instructional format of the classroom, family pressure to succeed, and the influence of exposure to new content areas as triggers for development in the child. In terms of the number of students whose academic growth in 1983-84 was primarily the result of only one of these influences, Logo is clearly less influential than almost all of these other factors, with the exception of tracking. On the other hand, Logo appears to complement or enhance the effects of these variables, as well as having a unique influence in its own right. What is Logo's unique contribution? Our conclusion is that Logo provides direct, high quality feedback to students about their intellectual promise regardless of their past educational achievement or their present rate of growth or change. In this sense, it appears that Logo provides an opportunity for students to explore intellectual and social roles in the classroom beyond those that are determined for them largely on the basis of their educational and prior social histories. Teacher and peer expectations in the classroom may be overturned on the basis of exceptional or exciting work on the computer, and such work may, thus, contribute directly to an increase in the student's self-esteem and, indirectly, to an improvement in achievement performance.
4. The 1983-84 research followed students over time, the first large-scale research on Logo to do so. Although the analysis of Logo effects over time has only just begun for this data set, some preliminary characteristics of the growth curve in student responses to Logo have emerged. Students seem to respond to Logo quickly and more or less unambiguously. That is, effects appear to be triggered soon after exposure to the language, and dramatic effects are not unusual after only a limited amount of time at the computer. It also appears that the growth curve becomes much more gradual the longer students work with Logo, but we must keep in mind that our data only cover a single academic year. Logo's long-range effects are completely unknown but, in the short term, Logo appears to influence a wide range of intellectual and social aspects of classroom performance within a minimum of time at the keyboard--for most students, less than 40 hours per school year.

5. The process by which diverse students are integrated into the educational system and taught to achieve desired intellectual and social skills is a complex one. Among the factors that influence this process are school resources, training and commitment in teachers, family background for the students, motivation and goal-setting in the students, and the little-known process of social comparison among students and teachers in the classroom. This last factor is emerging in research literature as a determining feature of the social system of the classroom, and the process by which students compare each other, and the evaluations made by teachers of their students, seem to have a great deal to do with the overall pattern of classroom achievement. Logo's singular contribution to the achievement process appears to be as a mediating influence on the social comparisons made in the classroom. It is unlikely that Logo will transform the cognitive characteristics of any student, apart from creating an opportunity for latent abilities to be expressed. However, this contribution is considerable. Teachers report that 71% of the students in Logo classrooms initially are attracted to Logo for reasons other than intellectual curiosity. Logo acts as a magnet for a truly diverse and fairly difficult student population; once attracted, the students respond with generally increased enthusiasm for the global process of learning. Our final analysis of this data will focus on the subgroups of students (low achievers; female vs. male; etc.) that may be responding in specific ways to the opportunity Logo creates in the classroom.

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Project ADAPT - Appreciating Differences Among People and Things - is a program in intercultural communication and understanding designed to develop attitudes of openness and appreciation for new people and new experiences. The program is sponsored by the St. Paul Public Schools and the University of Minnesota's Office for Special Learning Opportunities. It is taught by university interns representing a cross-section of backgrounds and academic disciplines. Some 80% of the interns in the 1984-85 program are international students from 22 countries.

Some ADAPT classrooms are also Logo classrooms. References to Logo are found in letters from St. Paul children to pen-pals in other countries, and in classroom journals kept by ADAPT interns. These spontaneous, undirected comments reveal much about what children see as important to them. They are strong arguments that children make creative personal decisions about their own behaviors.

A major goal of Project ADAPT is to increase children's understanding or awareness of the centrality of values in their own lives and the lives of others. But awareness and sensitivity cannot be taught directly. They develop out of certain types of emotional and intellectual experiences. The Logo presence in ADAPT classrooms engages children in new and different experiences that are global in perspective, e.g., individual judgment and adaptation to the technological and social changes of our time.

The following excerpts are from letters written by St. Paul children to pen-pals in Japan, Ghana, Spain, France, India and Greece.

Now I will tell you all about Logo. It is in our computer and it helps us to make beautiful things. You have to be sure to tell it the right things cause it will only do what you say and if you leave something out it says, "Not enough input" and you say, "Oh no, not again" and look for your bug (that means mistake). My mom says I am soooo lucky to be learning this.

I am a girl who really loves to use the computer. We do Logo everyday and everybody gets turns. My sister in high school says their teacher doesn't want girls in computer, but when I get there I'm going to do it! Do African girls get computer?

We have an Apple with a turtle inside it in our room. That is a riddle because the Apple is our computer and the turtle is Logo. It lets you do lots of things if you tell it how to. It is very fussy about spelling!

Another great thing we do is Logo computer. You think things in your head and then tell the computer how to make them on the screen. If you come to visit, you will have a turn.
The printout in this letter is from the Logo language. First our teacher went to learn it, and then she taught us and now we teach each other. If you have an Apple computer, we could send you a disk to see.

I am a dude who likes baseball and Logo.

In our class, we have Logo. It is a language for our computer. A man with a beard named Seymour made it so kids can have a chance too. It makes you think very hard but you would love it if you had it. It comes in French so ask your teacher. You can make almost anything if you try and try and keep thinking.

As you can tell from my greeting, we are learning a little Japanese from Pi. Another language I know is Logo. We have it on our Apple. I know a lot of computer stuff comes from Japan, but I think this comes from M.I.T. I am making a program with twenty different arcs and it is called Star Wars of the Turtles. I'll send you the printout. Please send me one of yours.

We have a happy corner in our room called the Logo space. It is where we are the boss and the computer learns from us. I never knew I had so much smart stuff in my head. Please come and visit so I can show you.

Here is a new riddle: "I am not an animal trainer and I do not work in the zoo, but I can teach a turtle to do tricks. Who am I?" Answer: "I am a Logoer." HaHa.

The following comments are taken from journals kept by ADAPT interns. The interns are from Iran, Ghana, Sweden, Japan, India, Nigeria, and Brazil.

Today they showed me all about their computer. They have Logo. This is their first year but they understand so much. They have pride in their work and in telling me how they figure things out. Paul, who can't read and is always angry, smiled doing his big tree.

The kids are sometimes rowdy but not by the computer. It has a triangle called a turtle and they can write or draw. Tim and Sally made my flag and gave me its program.

Because my major is Computer Science, I stay every time to have a Logo lesson. Then I am the student and they are the teachers. They keep saying, "We won't tell you how to make it. You must think it and then show the turtle what you want." Logo is amazing in how easy it seems and yet how sophisticated it really is. I may use it for my next C.S. project.

There are always two students in the back doing Logo. They are quiet but you can see their excitement. The teacher has an extra eye to see what they are doing and sometimes shows the whole class. Then you should see them grin!
Five kids are making Persian symbols in Logo. I will take them back to my childhood school this summer.

The room is Logo, Logo, Logo! Everybody wrote their pen pals about it. It is so important to them. It keeps their brains working.

I showed the kids what I do in my drafting class and they are trying it on the computer. The scale is five turtle steps = one foot. They are in third grade but they understand angles and degrees and use them. They want it three-dimensional.

I know I am sometimes critical of American students and their education, but when I see my eight-year-olds slaving over their Logo and always pushing themselves to new discoveries, I know they are achieving by choice what we only achieved by the threat of the whip.

At first I was insulted when the students left my lesson to take their Logo turn, but Mimi said, "Find out about it before you make up your mind." Now I spend two extra hours with the kids. We've written a Swedish vocabulary lesson (well, the students did most of the work but I'm learning). I'm planning to buy my own Logo and take it home this summer. My aunt is the head of our school and she is very excited to see it.

Reported by

Mimi Goldstein
Director, Project ADAPT

Anita Raturi
Graduate Assistant
University of Minnesota

May 1985
Research on the St Paul Logo Project has proceeded on three fronts during the 1984-85 school year. Theoretical, applied, and organizational/institutional perspectives has been directed toward the problem of understanding what Logo is and how it might be optimally used in an urban public school system. The theoretical approach continues in an analysis of survey data collected during the 1983-84 school year. We are concerned with several factors that deal in general with student performance in the classroom and in particular with student academic and social performance relative to Logo.

(1) We are asking what roles a student can play in the classroom and whether Logo usage substantially affects the range of role opportunities open to under-and low achieving students.

(2) We are also investigating ways of defining cognitive style in the student learner. Our hypothesis is that Logo's discovery learning format may enhance a student's capacity to move from more limited cognitive processing styles to less limited, more flexible processing styles. Our preliminary evidence supports this hypothesis when cognitive style is defined as "preferred problem representation" during instruction, and the student "types" of cognitive style are defined as: neither concrete nor abstract; concrete; abstract; both concrete and abstract.

(3) A third problem that we continue to address through our analysis of the 1983-84 data is the empirical definition of discovery learning. By this we mean, if Logo represents one form of discovery learning, and we can
catalog, via our data, its range of behavioral and intellectual outcomes, then what can we infer about the discovery learning process in general and the role of the Logo microenvironment in the public school classroom? Our assumption is that the classroom requires both social adaptation to an impersonal evaluation setting (a process many students reject) and an intellectual adaptation to the school's expectation of relatively continual individual skill mastery. Discovery learning in Logo may involve more or less unconstrained exploration in social role adaptation, intellectual problem solving strategies, or both. Our working hypothesis at this point is that Logo represents an important growth opportunity for students whose intellectual or social prerequisites for classroom learning are significant enough to effectively stall them in a rigid social or intellectual role, and that Logo especially represents an opportunity for those students disadvantaged on both accounts.

(4) Finally, our documentation of some 30 Logo effects and their relative strengths over the course of the school year has led us to the position of asking how each type of effect could be maximized in the classroom setting, and how different applications or modifications of the Logo micro-environment might best be matched to the needs of different learners or user groups.

To address this last problem, we decided to attempt a systematic accounting of the basic applications currently in use in the St. Paul project. In May 1985, we collected our first baseline data on 130 teachers across 18 schools. The object of our study was to lay the foundation for an applied Logo philosophy - that is, a statement of how Logo is actually used in urban public school settings, and what expectations can reasonably be attached to its usage. Our study is designed to allow us to describe to a non-Logo teacher/educator audience the pluses and minuses of our Logo system. As such we hope it will also foster a forum in St. Paul for the necessary relationships between teacher development, Logo usage and discovery learning, and traditional skill mastery instructional formats. We feel that the distinction
between approaching Logo as an educational philosophy and as an applied instructional format is critical for its success in the St. Paul project. We also feel that this articulation must be made by teachers pooling their collective expertise.

For this reason, we have begun in the last year to sketch out a longer range research agenda in which Logo should be able to be examined from within a number of organizational levels of the school system. That is, we want to ask not only, what is a Logo microenvironment, or what is a Logo classroom, but also, what is a Logo school? a Logo school system? What kinds of relationships among teachers, and among teachers and administrators, should be fostered to achieve an integrated Logo project? What observational research roles are open to teachers? And so on. Our principal objective in this line of questioning is to understand the organizational underpinnings of a successful Logo project. We assume that positive Logo effects at the student level are really the outcome of a community of efforts: administrative, instructional, corporate, and academic. Further, we feel that these collective efforts have been only loosely integrated, and that with better resource utilization, better inter and intra-interest group communication, and with continued support for advanced teacher training and in-service personnel, we will get a more realistic approximation of the actual ceiling Logo effects should display among urban public school students.
The tables on the following pages contain data from a survey of 130 Logo teachers in the St. Paul Public Schools in May, 1985. The sample represents an overall response rate of 70%. Teachers from four magnet schools newly brought into the system in the fall of 1984 accounted for a 47% response rate from among their group; the response rate for all other teachers in the Logo program was 80%.

The success of the survey can be attributed to both the Logo advisory Board, which oversaw the project, and to the continuing effort of St. Paul Logo teachers to bring equity and enthusiasm for learning into the public school classroom.

Questions about the data analysis upon which the report is based can be directed to:

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Q1. How is Logo most often used in your classroom?

A. in a lab or lab combination  20%
B. in a microenvironment  65%
C. in a direct instruction format  9%

Q2. Which of the following statements best summarizes your interpretation of what Logo is?

A. Logo is a flexible computer language or a programming language that may provide student users with experience in programming.  27%
B. Logo is a classroom instructional resource comparable to good texts, etc.  5%
C. Logo is a broad educational philosophy which emphasizes that all children can be powerful learners.  59%

Q3. On the basis of your classroom experience, please rate Logo's effectiveness as a teaching and learning resource for the educational objectives or formats listed below. Please rate each of those areas with which you have some familiarity.

(1) = ineffective  (2) = fairly effective  (3) = very effective  (4) = NR

<table>
<thead>
<tr>
<th>Area</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>basic instruction</td>
<td>19%</td>
<td>27%</td>
<td>24%</td>
<td>30%</td>
</tr>
<tr>
<td>remedial instruction</td>
<td>30</td>
<td>47</td>
<td>22</td>
<td>31</td>
</tr>
<tr>
<td>special education</td>
<td>18</td>
<td>20</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>advanced/gifted instruction</td>
<td>1</td>
<td>8</td>
<td>55</td>
<td>35</td>
</tr>
<tr>
<td>unstructured/non-directed (discovery) learning</td>
<td>3</td>
<td>13</td>
<td>77</td>
<td>7</td>
</tr>
</tbody>
</table>

Q4. Please rate the following aspects of your initial 40 hours of training on Logo.

(1) = inadequate  (2) = OK  (3) = superior

<table>
<thead>
<tr>
<th>Aspect</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>overall effectiveness in introducing Logo</td>
<td>6%</td>
<td>24%</td>
<td>68%</td>
</tr>
<tr>
<td>effectiveness in establishing your basic technical skills</td>
<td>9</td>
<td>36</td>
<td>54</td>
</tr>
<tr>
<td>presentation of Logo's educational philosophy</td>
<td>11</td>
<td>33</td>
<td>55</td>
</tr>
<tr>
<td>presentation of various teaching applications for Logo</td>
<td>33</td>
<td>39</td>
<td>26</td>
</tr>
<tr>
<td>opportunity for networking with other teachers</td>
<td>19</td>
<td>41</td>
<td>38</td>
</tr>
<tr>
<td>time to work on the computer</td>
<td>12</td>
<td>25</td>
<td>62</td>
</tr>
</tbody>
</table>
Q5. Please rate the following aspects of your current use of Logo.  
(1) = inadequate  (2) = adequate  (3) = more than adequate/superior

<table>
<thead>
<tr>
<th>Aspect</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of computers available for your classroom</td>
<td>32%</td>
<td>48%</td>
<td>16%</td>
</tr>
<tr>
<td>operational reliability of computers and software</td>
<td>2</td>
<td>30%</td>
<td>66%</td>
</tr>
<tr>
<td>availability of manuals, references, supplemental instructional material</td>
<td>18%</td>
<td>43%</td>
<td>37%</td>
</tr>
<tr>
<td>accessibility of support personnel (in-service teachers)</td>
<td>8</td>
<td>36%</td>
<td>55%</td>
</tr>
<tr>
<td>quality of service/information provided by in-service teachers</td>
<td>8</td>
<td>19%</td>
<td>68%</td>
</tr>
<tr>
<td>support from your principal in helping to integrate Logo into your school's curriculum</td>
<td>21</td>
<td>35%</td>
<td>38%</td>
</tr>
<tr>
<td>sharing, consulting on practical Logo applications by teachers in your school</td>
<td>30%</td>
<td>38%</td>
<td>30%</td>
</tr>
<tr>
<td>your ability to use Logo effectively in your classroom</td>
<td>13%</td>
<td>51%</td>
<td>35%</td>
</tr>
<tr>
<td>overall coordination of the Logo project by 360 Colborne</td>
<td>11%</td>
<td>35%</td>
<td>45%</td>
</tr>
<tr>
<td>overall support for the project by 360</td>
<td>11%</td>
<td>38%</td>
<td>44%</td>
</tr>
<tr>
<td>time you have to work on Logo yourself through the school year</td>
<td>62%</td>
<td>24%</td>
<td>8%</td>
</tr>
<tr>
<td>leadership by teachers with advanced training in helping teachers who have more recently joined the project</td>
<td>16%</td>
<td>39%</td>
<td>36%</td>
</tr>
<tr>
<td>extent to which the project overall has used Logo to address major issues in classroom teaching</td>
<td>45%</td>
<td>30%</td>
<td>15%</td>
</tr>
</tbody>
</table>
Q6. In some classrooms or in some grade levels, certain kinds of students may respond more or less enthusiastically to Logo than other kinds of students. Based on your classroom experience - if appropriate - please rate the following groups of students in terms of their responsiveness (on the average) to Logo.

(1) = minimally responsive  (2) = average  (3) = very responsive

<table>
<thead>
<tr>
<th>Group</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>low achievers</td>
<td>13%</td>
<td>29%</td>
<td>48%</td>
</tr>
<tr>
<td>high achievers</td>
<td>2</td>
<td>17</td>
<td>67</td>
</tr>
<tr>
<td>males</td>
<td>0</td>
<td>35</td>
<td>57</td>
</tr>
<tr>
<td>females</td>
<td>6</td>
<td>48</td>
<td>37</td>
</tr>
<tr>
<td>behavior problems</td>
<td>9</td>
<td>27</td>
<td>51</td>
</tr>
<tr>
<td>social isolates/loners</td>
<td>6</td>
<td>25</td>
<td>49</td>
</tr>
</tbody>
</table>

Q7. How often do you use the following formats in teaching or using Logo in your classroom?

(1) = infrequently/never  (2) = sometimes  (3) = frequently/quite frequently

<table>
<thead>
<tr>
<th>Format</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>assign specific Logo projects with a desired outcome</td>
<td>53%</td>
<td>31%</td>
<td>10%</td>
</tr>
<tr>
<td>present general lessons on specific Logo topics or techniques</td>
<td>26%</td>
<td>47%</td>
<td>23%</td>
</tr>
<tr>
<td>intervene with instruction or help when you see/think it's needed</td>
<td>21%</td>
<td>35%</td>
<td>41%</td>
</tr>
<tr>
<td>intervene only when asked</td>
<td>16%</td>
<td>41%</td>
<td>31%</td>
</tr>
<tr>
<td>look for the &quot;teachable moment&quot;</td>
<td>11%</td>
<td>31%</td>
<td>52%</td>
</tr>
<tr>
<td>structure different types of Logo problems, lessons, or assignments for different types of students or user groups</td>
<td>48%</td>
<td>30%</td>
<td>17%</td>
</tr>
<tr>
<td>use show and tell about students' Logo projects</td>
<td>30%</td>
<td>37%</td>
<td>27%</td>
</tr>
<tr>
<td>pool computers from other classrooms</td>
<td>68%</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>encourage students to teach or tutor each other</td>
<td>1%</td>
<td>19%</td>
<td>75%</td>
</tr>
<tr>
<td>assign some of your students to be Logo &quot;teaching assistants&quot; or aides for other students</td>
<td>29%</td>
<td>20%</td>
<td>45%</td>
</tr>
<tr>
<td>have students work in pairs or teams at a single terminal</td>
<td>9%</td>
<td>18%</td>
<td>68%</td>
</tr>
</tbody>
</table>
Q8. To what extent do you agree or disagree with the following statements?
(1) = disagree  (2) = neither agree nor disagree  (3) = agree

(1) (2) (3)

Logo probably offers something of educational value to most of its student users.  
6% 90%

Peer interaction (sharing, teaching, consulting) is important for Logo users.  
0 6 92

The Logo project has begun to be an effective tool for teacher development.  
12 31 51

Logo encourages students to be more independent of the teacher's classroom authority.  
12 31 50

Logo is probably best used as a learning "stimulus" for students' enthusiasm, or to decrease boredom, rather than being tied to direct instruction.  
30 31 31

Consistent follow-up training for Logo teachers is necessary for effective classroom use of Logo.  
2 12 84

Low academic achievers can become more effective learners or better classroom performers as a result of working with Logo.  
7 38 49

Q9. Demographic data (Proportions of teachers identifying themselves for a particular category are listed in parentheses).

Grade level: K-3 (32%) 4-6 (31%) 7-9 (9%) 10-12 (6%)
primary level special ed (12%) secondary special ed (8%)

Classroom population: mainstream (38%) special ed (19%) mixed/multiple (37%)

Number of computers: one (65%) two (17%) 3-6 (8%) 15-20 (8%)

Number of students: less than 20 (17%) 20-25 (23%) 26-40 (49%)
Educators in St. Paul have found that classroom computer use benefits all their student populations, as evidenced not only by academic success but by students’ increased enthusiasm for learning.

In the 1982–83 school year, the St. Paul public schools introduced the Logo computer language and educational philosophy into 26 classrooms. By June 1985, the project had grown to include 250 K-12 teachers who work in the full spectrum of urban public school settings, including special and remedial education, mainstream classrooms, and schools whose economic base ranges from very poor to predominantly middle class.

Implementing Logo

Every teacher in the project has undergone 40 hours of initial training in the language and its classroom implications. Advanced training and support from inservice teachers who helped pioneer the project are available, and Logo’s objectives mesh with a broader districtwide program called the Alliance for Effective Schools. The Alliance seeks to engage school administrators, teachers, parents, students, and concerned leaders from the public and private sectors in a dialogue about the substance and direction of public school education.

From the beginning, the Logo project has included a research component as one way of looking at how teachers and students respond to Logo in their classrooms. While the research was being conducted, the system was growing. Many remarkable anecdotes were accumulated and, along with the formal dialogue in the Alliance and the formal research agenda, an enthusiastic informal dialogue took shape, enriching and challenging the other two perspectives.

Of all the questions raised about computers in the classroom, it is significant to note that the Alliance and Logo projects have consistently returned to two: (1) how can computers be used to engage all types of students
Figure 1. Weighted Logo Effect Scores from 1983–84
Data on St. Paul Student Users (N = 385)

<table>
<thead>
<tr>
<th>Leading January Effects</th>
<th>Percent of the Maximum Weighted Effect Score (Relative Strength)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enthusiasm, excitement about learning</td>
<td>94</td>
</tr>
<tr>
<td>Sharing, teaching, consulting</td>
<td>91</td>
</tr>
<tr>
<td>Frequency of interaction with peers</td>
<td>90</td>
</tr>
<tr>
<td>Logic, structured thinking, planning</td>
<td>83</td>
</tr>
<tr>
<td>Likableness, sense of acceptance, belonging</td>
<td>80</td>
</tr>
<tr>
<td>Self-confidence</td>
<td>80</td>
</tr>
<tr>
<td>Cooperation, participation</td>
<td>79</td>
</tr>
<tr>
<td>Pleasure in work</td>
<td>75</td>
</tr>
<tr>
<td>Systematic problem solving</td>
<td>75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leading May Effects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Likableness, sense of acceptance, belonging</td>
<td>99</td>
</tr>
<tr>
<td>Sharing, teaching, consulting</td>
<td>99</td>
</tr>
<tr>
<td>Logic, structured thinking, planning</td>
<td>93</td>
</tr>
<tr>
<td>Pleasure in work</td>
<td>90</td>
</tr>
<tr>
<td>Frequency of interaction with peers</td>
<td>90</td>
</tr>
<tr>
<td>Self-confidence</td>
<td>89</td>
</tr>
<tr>
<td>Creativity, resourcefulness</td>
<td>84</td>
</tr>
<tr>
<td>Enthusiasm, excitement about learning</td>
<td>82</td>
</tr>
<tr>
<td>Spelling, writing</td>
<td>81</td>
</tr>
<tr>
<td>Concentration, memory</td>
<td>80</td>
</tr>
<tr>
<td>Motivation</td>
<td>77</td>
</tr>
<tr>
<td>Attention to detail</td>
<td>77</td>
</tr>
<tr>
<td>Use of quantitative relations, math</td>
<td>76</td>
</tr>
<tr>
<td>Cooperation, participation</td>
<td>76</td>
</tr>
<tr>
<td>Decrease in boredom in the classroom</td>
<td>76</td>
</tr>
<tr>
<td>Altruism, prosocial behavior</td>
<td>76</td>
</tr>
<tr>
<td>Level of achievement</td>
<td>75</td>
</tr>
<tr>
<td>Rate of learning</td>
<td>74</td>
</tr>
<tr>
<td>Decrease in isolation, shyness, passivity</td>
<td>73</td>
</tr>
<tr>
<td>Playfulness, curiosity</td>
<td>72</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Greatest Improvement from January to May</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spelling, writing</td>
<td>85 (increase in Rate of learning 84 weighted score)</td>
</tr>
<tr>
<td>Homework, class assignments</td>
<td>75</td>
</tr>
<tr>
<td>Level of achievement</td>
<td>73</td>
</tr>
<tr>
<td>Reading, reading comprehension</td>
<td>71</td>
</tr>
<tr>
<td>Descriptive power, coherence</td>
<td>66</td>
</tr>
<tr>
<td>Intuitive understanding, perspective taking</td>
<td>51</td>
</tr>
</tbody>
</table>

in learning? and (2) who is responsible for the quality and effects of the computer's impact on the classroom environment?

Most teachers in the St. Paul project establish a Logo "microenvironment" in one part of their classrooms. Typically, students take 20- or 30-minute turns at one or two microcomputers, often working in pairs at each terminal while regular classroom instruction continues. Using Logo, students define what are frequently complex graphics problems and solve them by programming the movements of a turtle on the monitor. Logo is often a powerful emotional experience for students and is extremely flexible for a variety of cognitive styles. It turns making mistakes and taking risks into advantages rather than disadvantages and, in a modified discovery-learning format, emphasizes the salience of the "teachable moment" type of intervention, when teachers are called on to articulate a student's discovery; confirm an intuitive, student-centered hypothesis; or debug an intellectual procedure.

**Research Findings**

In our 1983 and 1984 research, about half of all students were thought by their teachers to have improved in some aspect of their academic performance as a result of working with Logo. Ten percent of all student users showed dramatic improvement. Teachers were asked to indicate the degree of each student's improvement using 30 specific effect variables. Figure 1 displays, in order, the leading effects noted in January and May 1984, based on a weighting of the proportion of students improved in each area multiplied by the proportion for whom each effect was reported as significant. Also included in Figure 1 are those effects with the largest proportional increases (50 percent or greater) in weighted scores from January to May. The table suggests two things: (1) different kinds of effects from Logo usage may develop over time, with social effects preceding and developing in parallel with individual-cognitive effects; and (2) as might realistically be expected, the classroom environmental contingencies to student learning are complex and multidimensional. This second point is particularly relevant to schools approaching computer innovation as a simple phenomenon with an outcome that can be directly anticipated.

The list of Logo effects in Figure 1 is also an exciting testament to the opportunities that minimal computer exposure can create for public school students. On the average, these students spent only 40 hours of the entire school year using Logo, and the effects include cognitive and content skills and social-behavioral skills prerequisite to effective classroom participation and learning.
Likewise, there was little or no difference (less than 10 percent) between students in the highest two quintiles. There was literally no way to subclassify students that were reported. There was no of the student characteristics usually considered to be traditional predictors of academic success or failure (disruptiveness in the classroom, initiative, independence, cognitive style, and emotional development, for example) were predictive of improvement through Logo. From a research perspective, the tentative conclusion is that Logo effects seem to be both wide ranging and substantial, and appear to be available to students from almost any type of learning, social, or motivational background. Logo clearly represents an innovative way to create opportunities for academic success and enrichment for most students.

**Logo’s Educational Philosophy**

Although Logo is, in its most elementary definition, only a programming language, it also comes with an implicit and loosely defined educational philosophy. The philosophy is not nearly as powerful as the programming language, partly because it has not been sufficiently articulated by educators and partly because its core assumptions are explicitly Piagetian or developmental. This second aspect sets up a pro/con conflict between developmentalist and non-developmentalist groups of teachers with equally high levels of commitment to classroom excellence and success for their students.

In St. Paul, the articulation of a Logo philosophy is just beginning to take shape after almost three years. One of the critical aspects of our large-scale experiment with Logo and learning will clearly be the extent to which our philosophy is not a position but a dialogue. Further, it is arguable that the positive results of our data analysis are not simply the consequences of students working at microcomputer terminals and using the Logo language. In large measure, these results are also the effects of an educational community systematically articulating its values, aims, and practical classroom objectives for teaching and learning.

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**Taking the Risk**

To get Logo computers into the classroom and make them available to students, many people took extensive personal risks. The superintendent took a risk on a relatively unknown language and on the judgment of staff members with no computer background who researched the project and brought it into being. The Alliance coordinator took a risk in defining the Logo project as teacher-centered: with training required, teacher development strongly encouraged, and decision making for the course of the project decentralized to the schools whenever possible. Perhaps most important, teachers took a risk with Logo: they chose to accept into their classrooms an innovation that asked them to forego many of the controls and authority aspects of teaching, as well as the role of being the person who defines correct answers and proper solutions. In doing so, they were confronted with a gaping unknown central to both teaching and innovation: what if it works? Could they handle a class with everyone learning in different directions and working on a large range of student-defined problems with a fairly high level of excitement?

It is important to recognize how tentative we are (and must be) about our own knowledge and how aware of our own limitations we can become in the face of youthful, talented promise in the act of fulfilling itself or showing unexpected promise. The Logo teachers in St. Paul faced this difficult first hurdle of innovation, and in asking these questions they and the administrators behind them communicated to students something at least as intrinsically powerful as the Logo language itself: the commitment of an adult community, with diverse individual interests, to the concept of success for all students.

**Pete Fire Dog** is a doctoral candidate, Department of Sociology, University of Minnesota, Twin Cities. 1114 Social Sciences, 267 19th Avenue South, Minneapolis, Minnesota 55455.
PARTICIPATING SCHOOLS

GALTIER ELEMENTARY MAGNET SCHOOL
Science, Math, and Technology

GROVELAND PARK ELEMENTARY SCHOOL

HAYDEN HEIGHTS ELEMENTARY SCHOOL

HIGHLAND PARK ELEMENTARY SCHOOL

HIGHLAND PARK SECONDARY COMPLEX
  Junior High School
  Senior High School

Homecroft Elementary School

Horace Mann Elementary School

Jefferson Alternatives Secondary School

Maxfield Elementary Magnet School
Science, Math, and Technology

Monroe Community School, K-8

Murray Magnet Junior High School

Phalen Lake Elementary School

Prosperity Heights Elementary School

Ramsey Junior High School

Randolph Heights Elementary School
## PARTICIPANTS

### TEACHERS

#### ELEMENTARY

<table>
<thead>
<tr>
<th>Subject</th>
<th>Participants</th>
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<tbody>
<tr>
<td>Kindergarten-grade 8</td>
<td>115</td>
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<tr>
<td>TESOL K-6</td>
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#### SECONDARY

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<th>Subject</th>
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<td>Art</td>
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<tr>
<td>English</td>
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<td>English/Social Studies</td>
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<td>Home Economics</td>
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<td>Math/Computer Education</td>
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<td>Music</td>
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<td>Science</td>
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<td>Social studies</td>
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#### SPECIAL EDUCATION

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<tr>
<th>Subject</th>
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<tbody>
<tr>
<td>Kindergarten-grade 12</td>
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<td>Secondary Coop</td>
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<tr>
<td>Speech--</td>
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<td>Preschool</td>
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<td>7-8</td>
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<tr>
<td>9-12 Hearing Impaired</td>
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#### OTHERS

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<tr>
<th>Role</th>
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<td>Board of Education</td>
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<td>Community</td>
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<td>Librarians</td>
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<tr>
<td>Parents</td>
<td>6</td>
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<tr>
<td>Principals</td>
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<td>Psychologist</td>
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<td>Social Worker</td>
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<td>On leave, Retired, Transferred</td>
<td>17</td>
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