LOGO EXCHANGE

The Magazine for LOGO Activities Worldwide

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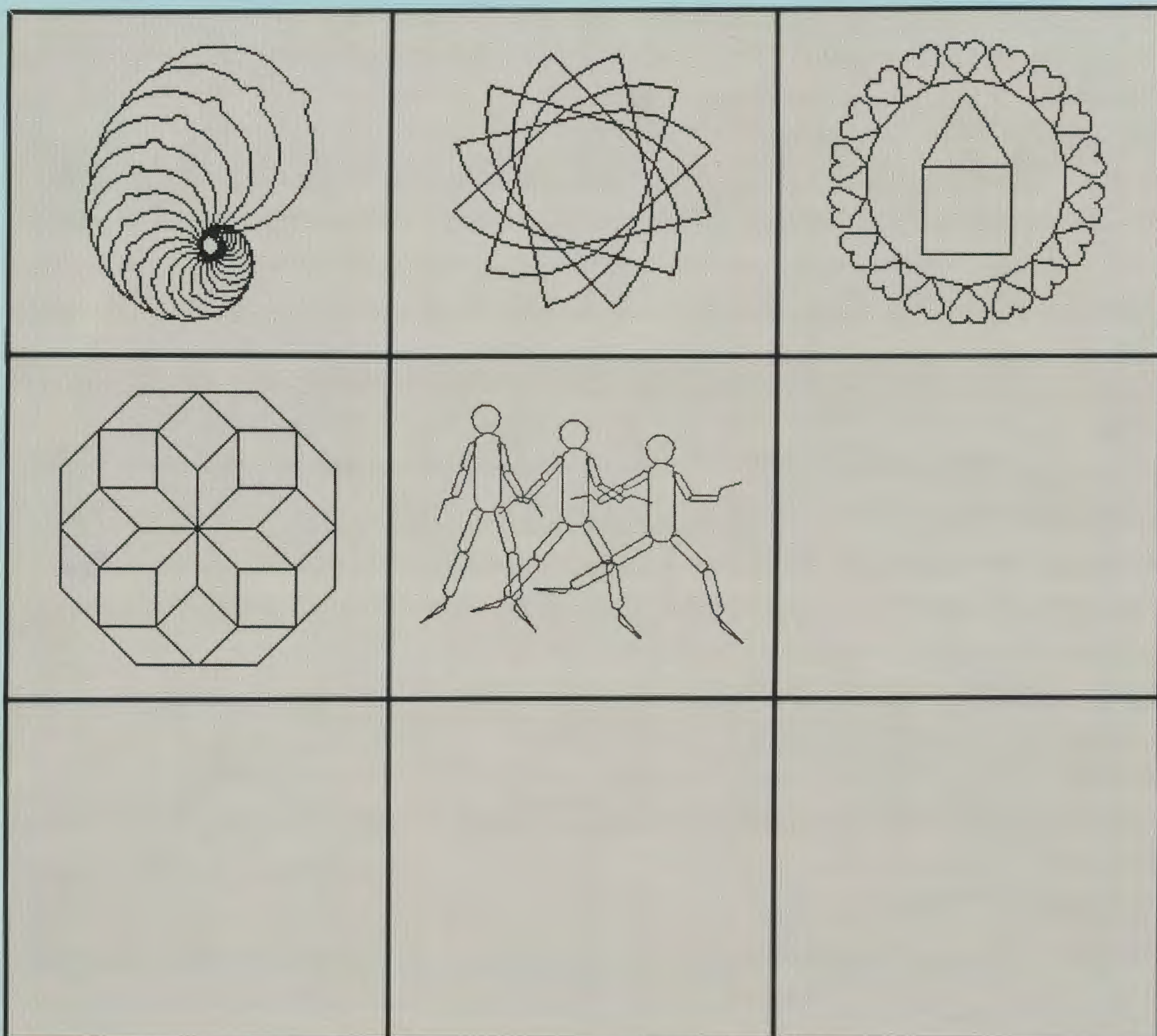

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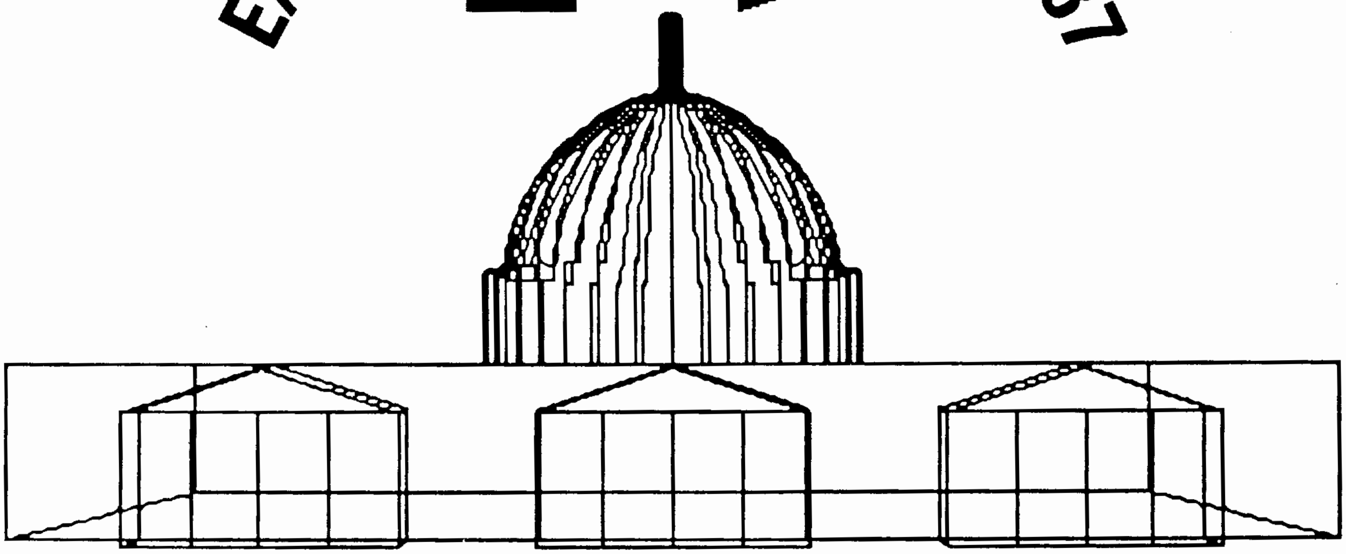

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International Logo News

Cover: The sequential Logo drawings of a dancer were contributed by Larry Robertshaw, a former student of Judi Harris at Beaver College in Glenside, PA.

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From the Editor

by Tom Lough

But I Already Know How It Ends...

Being born and raised in the beautiful Shenandoah Valley of Virginia did not give me the opportunity to be exposed to much opera as I was growing up. Recently, one of my former students offered Posy and me a pair of tickets to the Metropolitan Opera in New York City. Puccini's "Tosca" would be presented, with the famous tenor Placido Domingo in the starring role. Neither of us had ever been to a "varsity" opera, so I reached quickly for my checkbook.

One of our friends suggested that we obtain a copy of the libretto to read in advance. Another gave us a record album of "Tosca," so we could listen to the music.

As you might imagine, one does not just "up and go" from Charlottesville, Virginia, to New York City. There were travel and lodging arrangements to be made, work to be scheduled around, and a host of other details. But at last everything was ready. We boarded the train for our great adventure.

The train ride was quite enjoyable. As the miles clickety-clacked away, I began thinking about why we were making the trip. An absurd idea entered my mind. " Tosca kills herself at the end of the last act. Why are we going to all this trouble to see an opera when we already know how it ends?" Amused, I let the thought meander around a while, and then dismissed it.

It was later that the thought returned ... later, when we and several hundred others were on our feet, roaring our approval of a magnificent Met performance, pleading for just one more curtail call. Even though I had known the plot from reading the libretto and was familiar with the music from having listened to the records, the experience of *being there* was unexpectedly overwhelming.

I really should not have been surprised. The experience had masked the appearance of two familiar visitors of mine, Process and Product. In thinking these thoughts, I found that I had been forced to focus on the very essence of each of them.

Product emphasized the plot and its outcome, the completed musical score, the finished opera. Process directed my attention to the experience of the production itself, the thrill I felt as the magnificent Domingo sang, the anguish which surged within me as the emotionally tortured Tosca hurled herself off the battlement of the castle to join her lover in death. Neither a hundred listenings of the records nor a thousand readings of the libretto could compare to the experience of attending the opera in person.

On the return train, I thought about how the opera experience might affect my teaching. I resolved to emphasize more the experiences during our laboratory exercises, to acknowledge the importance of what goes on between laboratory partners. Perhaps I should have another look at how I grade my laboratory reports. Do I place too much emphasis on the printouts and the computer program designs, and not enough on the thoughts and interactions behind them? Do I have an attitude of "Check it off," as each laboratory exercise is completed, without any thought to its extensibility and applicability?

This same idea could be applied to the New Year, couldn't it? We all know how it is going to end. On December 31, 1987, we hope to be turning the calendar forward, just as we did recently. But think of all the opportunities we will have between now and then to value the process of our lives during 1987, as well as the final product at year's end.

Maybe this is what New Year's Resolutions are all about, anyhow...

FD 87!

Tom

Louisville Goes Logo

by Ric Manning

At Roosevelt-Perry Elementary School in Louisville, Kentucky, the Logo turtle has become the school's unofficial mascot.

Roosevelt-Perry, an inner-city school in a low-income, mixed-race neighborhood, was thrown headlong into the computer age three years ago. Humana, Inc., the Louisville-based hospital company, donated $150,000 to make Roosevelt-Perry a model for elementary school computer programs.

"Logo was a key element in Roosevelt-Perry's plans right from the start," said former principal Madeline Holland. The school installed MIT Terrapin Logo on a central hard disk, making it accessible for any of the school's 75 Apple-compatible Syscom terminals.

The school's 450 students get an average of three hours a week of computer time, either in the classroom or in a computer lab.

Roosevelt-Perry teachers say they like Logo because it helps teach students how to accomplish tasks by performing a logical series of steps.

"These are the kinds of things that are very difficult to teach," said Mrs. Holland.

"Logo is probably the most useful program we have," said J. Back, who succeeded Mrs. Holland as principal.

And Logo has been a hit with the students, too.

"I like the turtle," said first grader Tatasha Dickerson. "It's fun."

Logo Research Study

This year the school began a research program designed to test Logo's impact on general intelligence. Students in three third- and fourth-grade classes are using Logo to help develop the ability to visualize the relationship of lines and spaces.

"We think the REPEAT command is significant because it requires a student to see a pattern," said Back, "and we use the ability to see patterns as a measure of intelligence."

Working with educators from the University of Louisville, Roosevelt-Perry teachers put together a series of 15 lessons that use the REPEAT command to improve perception skills. By using the computer, Back said students can see how patterns are created and perhaps increase their ability to reason through problems.

Chuck Thompson, a University of Louisville instructor who worked on the project, said he believes the project is the first time Logo has been used to try to increase students' cognitive skills. (Ed. note: See Chuck Thompson's related article elsewhere in this issue.)

Back said the students received pre- and posttests on their Logo training, and on portions of the Cognitive Abilities Test, a test the Jefferson County school system uses to qualify students for its advanced program.

Back said they won't have final data on the intelligence question until later in the year, "but we feel that, just given the posttest, students learned a lot about Logo and the REPEAT command."

Teacher Training

Back said the school videotaped the instruction program and compiled the 15 lessons so the training can be used in other local schools. And he said teachers have been begging for that sort of curriculum assistance.

"(Seymour) Papert fought doing a curriculum," he said. "He wanted Logo to be a discovery process, for students to learn as they experiment. But we in the school business can't function too well without a sequence and a teaching plan."

Back and other school administrators have been big boosters of Logo training and of computer training in general. Since the computers were installed at Roosevelt-Perry, Back says attendance has improved, discipline problems are down, more parents have gotten involved in school activities, and students are learning some things faster.

"The kindergarten students are learning their letters and shape recognition much faster than we ever saw before," he said.

The school board is apparently also impressed. This year the board approved a $4.4 million program that will put an average of 32 computers in each of the system's 85 elementary schools.

Ric Manning covers computers and technology for The Courier-Journal in Louisville, KY.

East Coast Logo Conference '87 Advance Program Available

The Advance Program of the East Coast Logo Conference '87 is now available. Scheduled for April 2 - 4, 1987, in Arlington, VA, the conference features warmup activities, presentations on Logo applications and extensions, panel discussions, special interest group meetings, and social activities. The advance program also includes registration instructions and information on how to obtain the lowest air fares to Washington, DC. For a free copy of the advance program, write to ECLC '87, Meckler Publishing, 11 Ferry Lane West, Westport, CT 06880, or call (203) 226-6967.

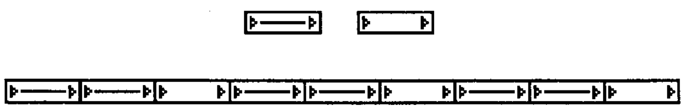
Creating Patterns and REPEATing Them

by Chuck Thompson

Logo's REPEAT command lends itself to the exploration of patterns. This idea became the basis for a series of lessons for a research study with fourth graders in Louisville, KY. The key components of these lessons could be modified slightly for use with younger children, or extended to be more challenging for older children.

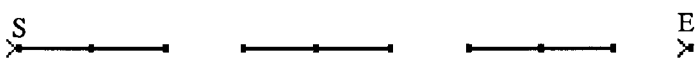
Key Idea: Concrete to Symbolic

A general plan for the instruction was first to provide experiences at the concrete level. The children used real objects to create patterns, and then verbalized the patterns. For example, they used small posterboard strips with "lines" or "spaces" to create patterns similar to the following:



The two triangles on each strip represent the starting and ending positions of the turtle for that particular strip. The pattern shown above would be verbalized as "line line space line line space line line space."

Next, children copied the pattern onto a dot line and extended the pattern by identifying the group of elements that was repeated over and over. This group of elements was called the "core" of the pattern. The core of the pattern above is "line line space." Note the small >'s denoting the starting (S) and ending (E) positions and headings of the turtle if it were to draw the pattern.



Then the children used Logo to draw the same pattern they had designed. This involved the use of two simple Logo tool procedures furnished by the teacher.

```
TO LINE          TO SPACE
PENDOWN          PENUP
FORWARD 10       FORWARD 10
END              END
```

Children used the REPEAT command along with the core of the pattern to write instructions such as

?REPEAT 3 [LINE LINE SPACE]

By this process, Logo could give an indication of the children's analyses of the patterns.

Key Idea: Simple to Complex Patterns

Four types of patterns comprised the instruction.

The first patterns were simple linear patterns built from colored cubes. Children became adept at identifying the cores and extending these patterns. It became easy for the children to write a "pretend" REPEAT command for these patterns. For example, a pattern such as "yellow red blue yellow red blue" could be thought of as

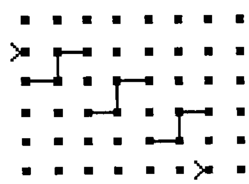
REPEAT 2 [YELLOW RED BLUE]

The second type of pattern was the simple linear pattern described earlier.

The third type used the same posterboard lines and spaces to make two dimensional patterns. These patterns are more complex, not only because they involve the use of LEFT and RIGHT turns of 90 degrees, but also because these turns are "transparent." That is, the turtle changes its heading and not its position at the turn point.

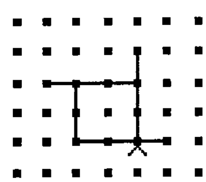
Nevertheless, the children became adept at identifying these turns, especially when they verbalized the patterns to a partner who "drove" a small turtle along a blank dot grid in an effort to recreate the pattern built from the posterboard strips. Instruction with these patterns first used the Logo procedures LINE and SPACE, but soon progressed to use of the standard Logo primitive procedures of FORWARD and BACK. Thus, the pattern below could be written as

?REPEAT 3 [PD FD 10 LT 90 FD 10 RT 90 FD 10 PU RT 90 FD 20 LT 90]



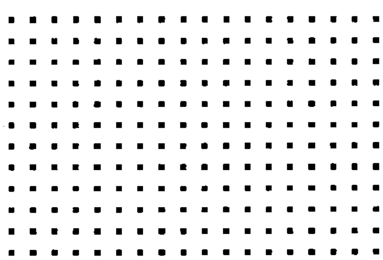
The final patterns used were also two dimensional, but, for the first time, the patterns resulted in closed figures. The commands for the pattern in the figure below could be written as

?REPEAT 4 [FD 30 BK 10 LT 90]



Final Considerations

The fourth grade teachers observed that the children became excited about, and capable of, using Logo to create patterns. This was facilitated by loading from the disk a picture of a predrawn rectangular dot grid. The dots on their grid were 10 turtle steps apart. Thus, the children could readily compare what they had drawn on dot grids with the result of the REPEAT command that was displayed on the computer monitor.



The research study results are being compiled, and we eagerly await the results. Meanwhile, we would be interested in learning what others have done with children in exploring patterns with Logo. Please write to:

Chuck Thompson
School of Education
University of Louisville
Louisville, KY 40292

Chuck Thompson is a professor in the Early and Middle Childhood Education Department of the School of Education at the University of Louisville, Louisville, KY.

Tipps for Teachers

by Steve Tipps

Lessons from Logo

Five years ago this month, Glen Bull and I embarked on an uncharted venture. Starting with 5 TI 99/4A computers and a class of 40 eager--but uncertain-- students (including Tom Lough), we began teaching with Logo. We had been to a Technical Education Research Center (TERC) workshop where Dan Watt introduced us to Logo. Glen spent most of the following week on the telephone to Texas Instruments until he found somebody who had the authority to ship 5 TI's. We unpacked the computers on a Sunday. The class started the next day!

TI Times

Logo consumed the rest of that semester; it was an exhilarating time. Logo was the first use of the computer which matched my beliefs about learning. I learned or relearned much from practically living in the laboratory while students experimented and struggled with Logo. I learned many lessons with Logo about computers, computing, and Logo. The whizzabongs inside a computer are less important than the computer operating in a dependable, troublefree manner.

Inside, the TI 99/4A is/was a wonderful computer with a 16 bit processor and (in its time) great graphics and sound chips. Outside, it was considerably less wonderful. Old-timers remember that the 16K memory expansion module weighed about 16 pounds and hooked onto the keyboard/CPU module something like cars on a train. If you wanted additional features, you added a new module. The footprint of a 64K system was approximately the size of six counties in West Texas. Of course in Lubbock, where they were built, space was no issue.

The couplings between the modules were tempermental and tentative. The slightest movement or jiggle could send Logo and procedures into the netherworld. At other times, the systems would heave a communal sigh and turn off. We never figured out exactly why; we suspected that the TI's were very sensitive to slight variation in current.

Hard Lessons about Hardware

The experience with the TI's taught me several important lessons about hardware. I am much less concerned all the technical characteristics of the computers. Put the computer down and see how it performs. Or, better, put it in a laboratory where it is used day after day by 100 different people.

A computer is of little practical value without a disk drive and a printer. You, no doubt, have the luxury of disk drives which work reliably. Five years ago, a spurious debate raged between the merits of saving to tape cheaply versus the "expensive" method of saving to disk.

Saving on the TI was a misadventure. A disk drive was available at a premium, but the people at TI did not send any. Glen bought a satisfactory tape recorder after many unsatisfactory attempts. The tape recorder could not be an ordinary one; it required a special polarization available only on a few brands. A few hardy students were able to save to tape, but I never managed to answer all twenty questions which were necessary to save and retrieve a file. Most students did as I did and started from scratch with each assignment which meant that you had to stay with your project until it was DONE.

Not having a reliable method of saving was compounded by not having any way to print. Students had to write out all of their procedures also. You may be thinking, "How primitive!" However, in the last year, several teachers have reported that their school delivered 2 to 5 computers without any printers.

Computers and Bicycles

Computing is more like riding a bicycle than like saying the ABC's. People have different styles of learning. Some like to be fully prepared and know everything before they start. People who want to know everything before they start give themselves very little room for mistakes. They seem afraid to fall off the bicycle because falling off shows they have not already mastered the skill. Having a lot of information in your head before working with a computer seems to be the wrong way to approach the task.

Riding a bicycle is a fairly difficult in the beginning. Many activities are going on simultaneously: steering, pedaling, balancing, watching the road, etc. Describing how to ride a bicycle is probably more difficult than riding. Describing how to use the computer seems to be just as difficult. Simultaneous awareness of entities and processes -- program or language, file or procedures, input and output -- is needed.

Unfortunately, a few mistakes seems necessary to bring words into reality. In laboratory, I have a habit of shouting out every 10 or 15 minutes, "Have you saved recently?" When someone has actually lost a chunk of work, they pay attention to warnings. "Now I understand what you mean," is the usual comment.

Computing is a skill which takes time to learn and is never perfected. When I sit down with Logo or software, I still get a little frightened that I have forgotten how to make it work. After a few seconds, the fear subsides but never goes away completely. I have learned to live with the insecurity of falling off and getting back up again.

Computing is a Social Event

One of my early concerns about computing was the possible dehumanizing aspect, or as it turns out myth. In one semester in the laboratory, I had more interaction with students and students more interaction with each other than in any other class. This phenomenon has happened in almost every computing situation I have observed from kindergarten through college. Student talk to each other, ask questions, use each other as resources, problem solve, argue, and laugh. The bonding may occur as a defensive response; however, I believe that the behavior is almost inevitable when people work on things which matter to them. The computer is a chameleon which changes to the user's need and desires.

Two situations I have observed which do not facilitate the social aspect were situations structured to prevent it. Individual carrels with substantial walls were used to block communication. Tightly controlled question-and-answer programs also inhibit sharing; they are constant inquisitors and most allow only the right answer.

I value the caring and cooperation in computing and try to infuse that spirit in other classes. Pair or group projects are part of almost every class. I want to generalize to "Learning is a social event."

There Must Be an Easier Way

When I am working with students in Logo or other applications, I state that the most important phrase for them to remember is, "There must be an easier way." Thus forewarned, students are allowed to do things the hard way until they complain.

Students can draw squares with REPEAT 4 [FD 50 RT 90] forever, but good computer users says to themselves, "This is dumb. Isn't there a better way?" Recently working with teachers on Appleworks, I demonstrated how to type the formula for average @AVG(B5...B13). I continued to type the formula two or three more times until somebody challenged me for an easier way.

One feature of Logo and many "blank page" applications is their adaptability to your level. One evening in a class for intermediate Appleworkers, teachers had been creating new layouts for a data base rather than duplicating existing layouts. The option was on the menu, but they had not challenged the program to do it the easy way. Optimizing computer use comes from constantly asking for an easier way.

Power Comes from Understanding

A fifth grader had learned to make the screen flash on and off repeatedly. He bartered his technique for gum. The REPEAT 1000 [BG 1 BG 2 BG 3 ...] soon filled every screen. The student had given his technique, but not necessarily the power of his discovery. The real power in Logo goes beyond making a square or flashing the screen. Logo provides many commands and techniques to make things happen. Under the ability to make things happen lurks powerful knowledge. Many Logo learning situations, I fear, have concentrated on techniques and commands rather than the understanding.

I am not advocating a lecture on "what you should have learned in Logo today." Instead, I want students to become more aware of the knowledge which is just below the surface. They need much exploration time, but they also need help to express the ideas. Making squares, triangles, and circles is fun and exciting. But making the shapes without ever recognizing the rule of 360 means missing the powerful knowledge which is useful in many ways.

Not Everybody Loves Logo

So many people enjoy the freedom and openness and fun of Logo, I have had a hard time learning the lesson that not everyone has to love Logo. At first, I thought that they simply lacked experience, were frightened of computers, or possibly were dumb as stumps. Not liking Logo was the computing equivalent of disdaining apple pie. However, I now accept that some otherwise perfectly nice and normal people, for whatever the reason, do not love Logo. I don't understand it, but I try not to look at the 1-in-30 who do not to love Logo as if they had snakes in their hair.

New Lessons Every Day

The lessons from Logo continue to guide my learning and teaching. I am as excited about computing and the power it gives people, but I am less parochial about Logo than I was five years ago. Word processing, Print Shop, and Rocky's Boots are also tools and environments for thinking. Logo continues to be at the heart of my personal computing philosophy, but other programs also offer joy and power. The greatest lesson is that each new day offers new possibilities and new lessons to learn.

Steve Tipps is the West Professor of Education at Midwestern State University in Wichita Falls, TX, and has been involved with Logo since 1982. He conducts Logo workshops for school systems throughout the United States, and is a popular conference speaker. His CompuServe number is 76606,1623.

Teacher Feature

by Rebecca Poplin

Featuring: Michael Charles

Infection

Logo is like a rare contagious disease. Most of us catch Logo from a friend or colleague who is excited about its potential. With some, the disease is more virulent than others. Michael Charles, a sixth grade teacher at Pendergast Elementary School in Phoenix, Arizona, caught a good case of Logo from Stephen VanHerpen, the computer lab teacher. Rather than seeking a cure, however, Michael is trying to nurture his infection and spread it to others.

Michael learned Logo while he was working with a group of students during the summer. He talked his school into providing the space and letting him use the computers to work with students just so he could learn Logo by their sides. Michael launched his teaching career in a similar way. He went to a Mississippi housing project to live and work with the residents and left with a change of direction. As an English major, Michael had been planning to teach at the college level but decided that he wanted to affect people's lives more than people's ideas. Teaching younger students seemed to fulfill his purpose better.

A corner was turned in Michael's teaching career when Steve showed him a videotape of Nova's "Talking Turtle" segment. Immediately Michael realized that Logo provided a door to change to the kind of teacher he wanted to be. Prior to Logo, Michael was much more structured and tended to operate on a "Here-is-your-work-Do-it" basis. He had felt that a lot he did was stifling but didn't know a way out. Logo opened the door to a whole new way of teaching.

Incubation and Growth

Recently, Michael has been using an approach to teaching writing that he would not have accepted prior to his Logo experience. The one-to-one instruction and small editing conferences with students recommended by Donald Graves are changing the writing activities in his classroom. Michael sees some similarities between the Graves approach to teaching writing and his own approach to Logo. Both involve focusing students on a personal task within a theme, serving as a guide, working individually, and leading students into solving problems. Both approaches often lead toward a product in which the students are highly involved and motivated.

Usually, Michael and Steve assign open-ended projects such as creating an interesting stick figure using Logo. Their project approach averts the "filling up the screen" every Logo teacher has seen. Other projects include making initials, designs with squares and triangles, and the "Twelve Days of Christmas." Each student drew one day of Christmas. Steve wrote the Logo procedures to play the song, and they brought in visitors to see the sound and light show. One project the students themselves invented was to create a neighborhood. If students didn't like a particular project, they could propose their own plan.

Contagion

One of the ways that Michael is spreading his enthusiasm for Logo is through his work with Dr. Gary Bitter at Arizona State University. Michael is doing active research in the lab as he and Steve work together. Last year 's project was more of a case study designed to answer particular questions. The situation was an extended day program for 15 Chapter II students, all of whom were low achievers. In order to qualify, students had to be in the bottom third of the class. Most were very active boys whose normal attention spans were short. With Logo, they would work for an hour and a half four days a week after putting in a full day at school. Unlike other extended day programs, students did not drop out.

Michael's study had three parts. First, he took observation notes as the students were involved. The purpose was to categorize teaching activities. Michael developed a schema of 10 different levels at which teachers would interact with students. He discovered a greater depth of teacher involvement and direction than the term "discovery learning" would imply.

The second part of the research involved looking for the kinds of thinking students were doing. Using Bloom's taxonomy, he wanted to find out whether Logo activities were stretching students to the higher levels. Michael was able to document a lot of powerful problem solving.

Michael was curious about Roy Pea's belief that students weren't understanding much if you did discovery teaching. He asked students to step through some procedures to determine if they understood them. Generally, students could reconstruct what the turtle was doing. This was particularly impressive since there had been quite a time lag between the creation of the procedures and this activity.

Michael is still working on his research, and hopes to share it in some meaningful way with other interested educators. If you would like to get in touch with him personally, write to:

Michael T. Charles
6813 North 29th Avenue
Phoenix, Arizona 85017

If you know of teachers who should be featured in this column, please write to:

Rebecca Poplin
2421 Fain Street
Wichita Falls, TX 76308

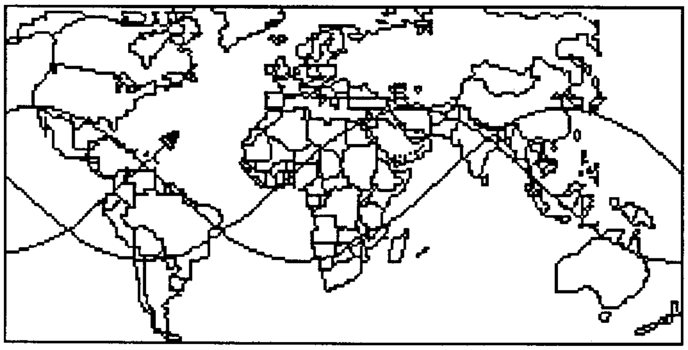
Rebecca Poplin uses Logo to teach junior high computing and mathematics in Wichita Falls, TX.

Teaching Tools

Glen Bull and Paula Cochran

Science and Sensors

A simulation is one way of using a computer for science. In a past column, we demonstrated how the SIN function in Logo could be used to simulate a sound wave, or the path of a spacecraft across the face of the earth (Bull and Cochran, 1986). Many microworlds in Logo are simulations. For example, dynaturtles are simulations of laws of physics which allow students to experiment with Newtonian laws (diSessa, 1982). Scientists often use computers to create mathematical models of possible experiments.



Simulations have a valuable place in both science and science education. However, there is a definite danger when simulations are used to replace the real thing. Simulations are less expensive and require less setup time than real experiments do. A worrisome concern is that school systems may attempt to save money and effort by substituting simulations for actual experiments.

Another way of employing a computer in science is to use the computer to acquire and analyze data in the conduct of the experiment itself. Scientists have found the computer can serve as a flexible, programmable instrument. The computer has the same attraction for schools. It can be used to collect and analyze data, replacing a collection of single-function scientific instruments which are too expensive for educational use.

Bob Tinker, president of Technical Education Research Center (TERC), has used the term "Microcomputer-Based Laboratory" (MBL) to describe the the use of the computer as a scientific instrument in science education. Tom Lam describes an MBL as a "laboratory where a microcomputer gathers and displays data directly from the environment." (Lam, 1984-85, p. 1)

Attaching a Sensor to the Computer

In this column we are going to discuss creation of some generalized Logo science tools which can be used to acquire data from many kinds of sensors. Sensors which can be attached to the computer include motion detectors, light cells, and temperature gauges. Many microcomputers have a data collection interface built into the computer itself. This data acquisition port may sometimes go unused because it is called a "GAME PORT". However, the game port of an Apple or an IBM is actually an "analog-to-digital (A/D) converter". It converts data from the real world into digital information which the computer can understand.

We suspect that this analog-to-digital converter would be used more often in schools if it were called a "data acquisition port" rather than a "game port". In order to use the data acquisition port, it is only necessary to attach a sensor to it, and create some software tools to acquire data from the sensor.

The simplest and most commonly available sensors are game paddles and joysticks. Again, there is a terminology problem here. In some schools these peripheral devices are not available (although they should be) because administrators are reluctant to budget school funds for "game" paddles and "joy" sticks. However, if you do not have access to a game paddle, you should be able to find one for $10 to $30 if you shop around. Since a game paddle is actually a "potentiometer," you may want to use that term when you request funds.

Software Tools

We are now going to assume that you have a game paddle or joystick plugged into the game port ... er, pardon us. What we meant to say is that we now assume that you have the potentiometer connected to the data acquisition port, and that you are now ready for some software to read the A/D converter. What a difference terminology makes.

Reading the sensor is a fairly simple matter in Logo. Try this procedure.

```
TO READ.SENSOR
PRINT PADDLE 0
READ.SENSOR
END
```

First, run the procedure. Then turn the paddle or move the joystick. As you do this, you should see the numbers printed on the screen shift from 0 to 255. As you turn the paddle one way the numbers should increase, and as you turn it the other way the numbers should decrease again. Essentially, the analog-to-digital converter is converting the analog rotation of the paddle into numbers for the computer.

```
?READ.SENSOR
0
15
55
130    <---- Paddle is turned to the right.
180
250
190    <---- Paddle is turned back to the left.
140
105
80
25
0
```

In order to stop the procedure, it will be necessary to use the Logo interrupt key for your version of Logo. (Control-

G in Apple and Terrapin Logo, Open-Apple Escape in Apple Logo II, and Control-Break in IBM Logo.)

Experiments with Motion

If you have the sensor attached to the computer and are getting satisfactory readings, we are ready to begin some experiments. In a previous column we used the SIN function in Logo to generate a sine wave. In this experiment, we will use the natural motion of a pendulum to create one.

To create a pendulum, it will be necessary to attach a rod of some kind to the game paddle or joystick. As the rod is lifted and allowed to swing back and forth, the motion of a pendulum results. There are several places you might find a rod. We found a metal rod about a foot long lying in the corner of our lab. Most hardware stores carry wooden dowels, or possibly a ruler or yardstick will suffice.

There are also several possible ways of attaching the rod to the game paddle. An elegant way involves removing the knob of the game paddle from its shaft, drilling a hole in one end of the rod, and pushing it onto the shaft of the paddle. Another possibility is to clamp a pair of Vise-Grip pliers onto the knob of the game paddle and use that in place of the rod. We must confess that we attached our rod to both the game paddle and the joystick with liberal amounts of tape.

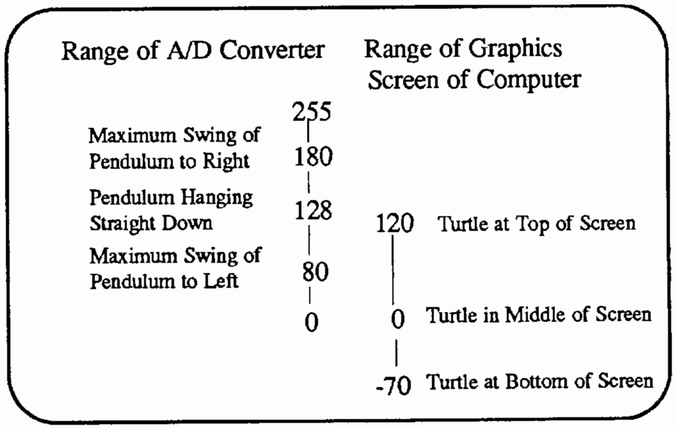
Calibrating the Pendulum

Once your pendulum is constructed, lift the rod and allow it to swing back and forth freely. It should swing back and forth two or three times before stopping. Run the READ.SENSOR program as the pendulum swings. The numbers displayed should increase as the pendulum swings one way, and decrease as it swings the other. It may be necessary to attach a weight to the end of the pendulum to make it swing more freely (just like the weight on the end of the pendulum of a grandfather clock).

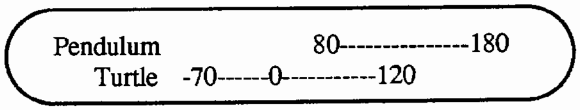
Turn the game paddle so that the numbers displayed read 128 when the pendulum is hanging straight down. The reason for choosing 128 is that it is halfway between the full range of 0 to 255. Now anchor the game paddle in this position. If you have access to a chemistry lab, you may be able to use one of the stands with a clamp that holds test tubes and bottles. We taped the game paddle to the side of a desk to hold it in place.

Scale and Offset

The next step is to create a graphic display of the motion of the pendulum. This can be done by translating the numbers produced by the movement of the pendulum into a motion of the turtle. There is one potential problem. As the pendulum swings, it will probably generate numbers between 80 to 180. However, the y-coordinates of the turtle range from -70 at the bottom of the screen to 120 at the top. (Some of the space at the bottom of the screen is used up by the four lines of text in the splitscreen mode.)



The turtle can be moved up and down as the pendulum swings back and forth. However, as the pendulum moves to the right, it will generate numbers which move the turtle off of the top of the graphics screen. The solution to this problem is to slide the range of numbers generated by the pendulum into the range of numbers which the turtle can display. The easiest way of accomplishing this is to subtract 100 from the number generated by the pendulum. Thus, 180 - 100 will become 80.



The following procedure translates the movement of the pendulum into a corresponding movement of the turtle. Be sure to leave a space between the minus sign and the number 100. Note to Terrapin users: In the examples which follow, substitute "SETXY" for "SETPOS LIST". For example, type SETXY XCOR (PADDLE 0) - 100 in the procedure below.

```
TO MOVE.TURTLE
SETPOS LIST XCOR (PADDLE 0) - 100
MOVE.TURTLE
END
```

Run the MOVE.TURTLE procedure. As the pendulum is moved to the left, the turtle should move to the bottom of the screen. As the pendulum is moved to the right, the turtle should move to the top of the screen. When the pendulum is straight down, the turtle should be in the middle of the screen.

The position of the turtle when the pendulum is straight down can be adjusted by changing 100 to another number. Experiment with different numbers to discover the effect on the turtle's position. This number controls the offset of the turtle. Offset is used to translate one range of numbers into another range. Adjust the offset until the turtle is in the middle of the screen.

You may find as you move your pendulum that the turtle goes off the top or bottom of the screen. If this happens, the problem is that the range of numbers generated by the pendulum is too great.

Pendulum -100-----------0---------------150
Turtle -70------0-----------120

The way to compensate for a range of numbers which is too great to fit on the screen is to change the scale. In this case, if we want the scale to be reduced by 60 percent, we will multiply by 0.6.

```
TO MOVE.TURTLE
SETPOS LIST XCOR ((PADDLE 0) - 100) * 0.6
MOVE.TURTLE
END
```

Scale and offset frequently appear in algebra. For example, in the formula,

$$Y = AX + B$$

the variable A is used to adjust the scale, and B is used to control offset. The difference is that, in this case, scaling and offset appear in the natural context of a real-world problem. Hence, the concepts are more likely to appear meaningful and to be understood.

Logo Challenge

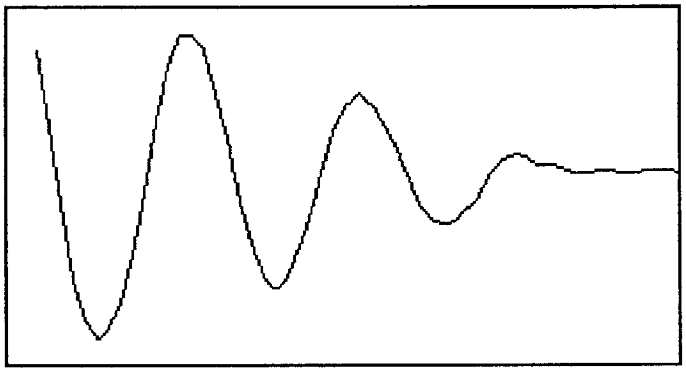
In order to move the turtle down, will it be necessary to increase value of the offset or decrease it?

Creating a Graphic Display

A graph of the pendulum's movement across the screen can be created by making one slight change to the MOVE.TURTLE procedure. Adding 5 to x-coordinate in between each point will move the turtle across the screen, creating a plot of the pendulum's movement.

```
TO SHOW.GRAPH
SETPOS LIST XCOR + 5 ((PADDLE 0) - 100) * 0.6
PRINT YCOR
SHOW.GRAPH
END
```

As the pendulum swings back and forth, a graph of its movement appears on the screen. This graph looks very much like a graph of a sine wave, except that the movement gradually dies down and stops. This is the result of a phenomenon known as "damping", which is present in the real world but which was not included in our May 1986 simulation.



Other Challenges and Other Sensors

In this column we have shown how a sensor can be connected to the computer, and used to examine an event in the outside world. A number of experiments and instruments suggest themselves. For example, what happens to the period of each cycle as the pendulum gets longer? With the right kind of calibration, could you use the potentiometer to create an electronic level, or possibly a motion detector?

Once you have tried a motion sensor, you may want to try other kinds of sensors. Broderbund Software (17 Paul Drive, San Rafael, CA 94903-2101, (415) 479-1170) offers a "Science Toolkit" which contains inexpensive light sensors and temperature gauges. These sensors can be used be with software included with the "Science Toolkit" or with Logo software tools.

Connecting a sensor to your computer opens up another world. Connecting the real world to the computer allows students to test hypotheses for themselves. Students often find that real phenomena are not as well-behaved as idealized simulations, and that real data are sometimes messy. Next month, look for more Logo science tools for analyzing the data collected with your sensors.

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TO BEGIN :VARIABLES

by Elaine Blitman and Barbara Jamile

VARIABLE: the idea of using a symbol to name an unknown entity ... one of the most powerful mathematical ideas ever invented.

---Seymour Papert, *Mindstorms*

Children who use variable procedures find them among the most useful and exciting features of Logo. Variables encourage exploration by enabling the user to see the effect of changing inputs with minimum effort. This month's column gives you some practical, teacher-tested ideas for introducing and using variables.

What is a Variable?

Variable means subject to change or alteration. Logo variables allow one procedure to do the work of many. A variable STAR procedure might make a star of any size, for instance. In such a procedure, a "placeholder" reserves a spot for specific input to a command, permitting the user to change or alter the input each time a procedure is run. A side-by-side comparison of a fixed procedure with a variable procedure illustrates the differences:

```
TO STAR                         TO VSTAR :STEPS
REPEAT 5 [FD 50 RT 144]         REPEAT 5 [FD :STEPS RT 144]
END                             END
```

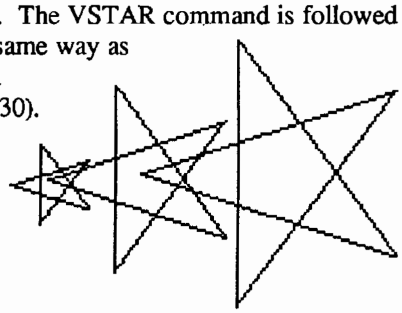
Notice that the placeholder in the VSTAR procedure appears in both the procedure title and following the FD command where the input is needed. Any name can be given to the placeholder, as long as it isn't the name of a Logo primitive procedure.

Selecting an appropriate variable name can help students understand the function of the input. For instance, STEPS is more descriptive than XXX.

We refer to the symbol (:) in front of the variable name as "dots." Because the variable sign is in a different position than a colon in relation to a word, and has a different purpose, it seems best to give the (:) symbol a new name as it is used here.

The STAR procedure draws stars exactly the same size every time. The VSTAR procedure requires the user to input the number of steps (length of side) when it is run, making stars of any size specified. The VSTAR command is followed by the input, in much the same way as the FORWARD command is used (e.g., FORWARD 30).

VSTAR 30
VSTAR 70
VSTAR 100



When Should Variables Be Taught?

When children are confident procedure writers and demonstrate an understanding of commands and inputs within a procedure, they are ready to learn about Logo variables. Children have usually worked with variables before, although this term was probably not used.

The spaces in a fill-in-the-blanks sentence are placeholders for variable input:

My name is ______ and I am _______ years old.

The box and letter symbols used in equations are also placeholders:

$\square$ times $\square$ = 12

$x + 9 = \square$

$2x + y = 13$

Look around the classroom to see examples of other variables children use frequently. A review of familiar uses of changeable inputs provides a connection to Logo variables. We've found that, in order for children to make the connection among types of variables, however, it is necessary to point out and work with various examples.

Before students go to the computer, help to reinforce their understanding of variable concepts with some concrete activities:

1. Place cards numbered 1 through 10 in a box. Ask students to turtle-walk a procedure such as this:

```
TO SQV :STEPS
REPEAT 4 [FD :STEPS RT 90]
END
```

The "turtle" must pick a number from the box to obtain the input for :STEPS before completing the procedure. Show the differences in the sizes by marking where the "turtle" walked with tape or chalk on the floor.

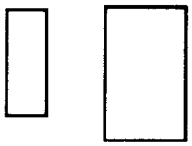
2. Ask students to write a procedure for an action on the chalkboard. Use a variable for the input following REPEAT. Take turns following the procedures, picking the input number from the box each time.

```
TO PAT :NUMBER
REPEAT :NUMBER [PAT.YOUR.HEAD]
END

TO JUMP :NUMBER
REPEAT :NUMBER [HOP]
END
```

More than one variable can be used in a procedure; in fact, even second and third graders can manage multiple variables after a sufficient amount of experience with a single variable.

```
TO RECTANGLE :SIDE1 :SIDE2
REPEAT 2 [FD :SIDE1 RT 90 FD :SIDE2 RT 90]

END
```

Try:



RECTANGLE 40 15
RECTANGLE 50 30

Here is a useful procedure with two variables.

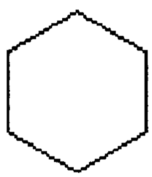
```
TO POLYGON :NUM :STEPS
REPEAT :NUM [FD :STEPS RT 360 / :NUM]
END
```

Regular polygons of any size can be made with this procedure. For example, POLYGON 5 30 makes a pentagon and POLYGON 8 30 makes an octagon. Challenge students to find the correct name for the polygons they make. What do you call a regular polygon with 6, 9 or 11 sides? What do you call a figure with 50 sides?

Color can become a variable:

```
TO POLY :NUM :STEPS :COLOR
SETPC :COLOR
REPEAT :NUM [FD :STEPS RT 360 / :NUM]
END
```

Try:



POLY 6 50 3

When writing Logo music, a procedure can be written for each note, using a variable for the duration. This allows the same procedure to be used for whole, half, quarter, eighth, and sixteenth notes:

```
TO F# :DURATION
TONE 657 :DURATION
END
```

Try:

F# 24
F# 18
F# 6

Hear the differences? The next procedure shows how notes are combined to play a scale. Notice the use of the variable to change the length of the notes from one scale to the other.

```
TO SCALE
C 24 D 24 E 24 F 24 G 24 A 24 B 24 C.HI 24
C 6 D 6 E 6 F 6 G 6 A 6 B 6 C.HI 6
END
```

```
TO C :DUR
TONE 523 :DUR
END

TO D :DUR
TONE 587 :DUR
END

TO E :DUR
TONE 659 :DUR
END

TO F :DUR
TONE 698 :DUR
END

TO G :DUR
TONE 784 :DUR
END

TO A :DUR
TONE 880 :DUR
END

TO B :DUR
TONE 988 :DUR
END

TO C.HI :DUR
TONE 1046
END
```

Variable subprocedures can be used within superprocedures. A familiar example of this is the HOUSE project found in many Logo books. By designing a variable procedure to make houses of different sizes, a neighborhood or town can be constructed.

Variables play a major role in words and lists procedures. A good understanding of variables in turtle graphics can transfer to words and lists concepts.

Challenge Activities

Challenges, whether posed by students or teachers, require problem solving and should include good writing habits. After solutions have been found, students should edit their programs to achieve elegant, concise, and easy-to-read forms that others can readily understand. Subprocedures and variable procedures should be incorporated wherever possible.

Write procedures using variables for the following:

Create a "variable" creature that can be drawn in several sizes. Write a history describing the creature at different stages of its life.

Next month: Circles, arcs, and curves with variables.

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Logo LinX

by Judi Harris

From A Different Angle

I'll never forget that scene.

Voice over: *When you've used mathematical principles as a key to enjoyable physical activities, your feeling for mathematics is likely to be warmer, more personal, more engaged.*

---Seymour Papert in *Talking Turtle*, a NOVA program produced by WGBH Public Television

Two young girls in black leotards performed a dance to a pulsating rock-and-roll song, mirroring each other's graceful movements.

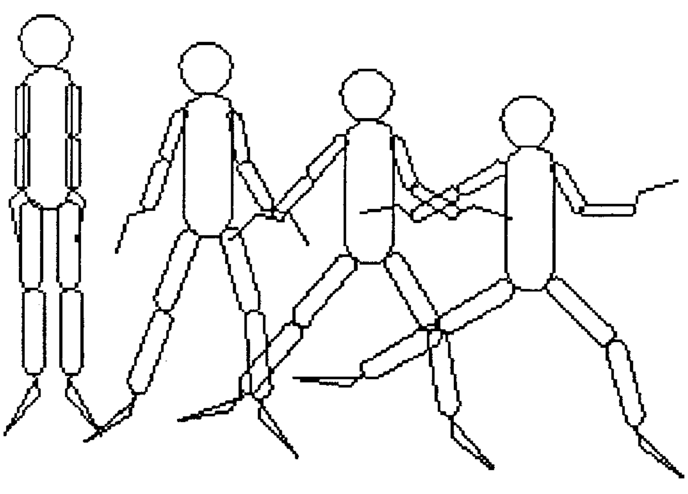
Voices over: *We wrote the dance like we wrote the procedures for the computer.*

--Mandy and Michelle in *Talking Turtle*

As Mandy and Michelle cartwheeled across the floor on my television screen, I felt another set of Logo project ideas begin to percolate in my subconscious.

I dream of helping more children experience mathematics as I do, with all the intimacy of dancing.

---Seymour Papert in *Talking Turtle*



Logo drawing by Larry Robertshaw, Beaver College, 1984

Winter break is over. Many of you are now settling in to four months of uninterrupted school days. The weather is cold enough in many states to move gym classes inside, and physical education teachers can now spend some weeks on gymnastics, dancing, or yoga units. Why not integrate some Logo explorations into these naturally appealing physical activities?

We are all familiar with the facilitative effects of kinesthetic experiences of abstract concepts for learners. Encouraging children to "play turtle" as an integral part of the Logo graphics problem solving process is probably a well-established part of your "facilitator's repertoire" by now. Why not capitalize upon this symbiotic relationship between cognitive and physical activity?

Angular Notions

At one elementary school, it all began with a bulletin board. During one of my "I-need-to-relax" trips to a local bookstore, I happened upon a paperback authored by Olympic gymnast Kurt Thomas. (*Kurt Thomas on Gymnastics*, Simon and Schuster, 1980.) It contained many beautiful black-and-white photographs of his work on the rings, horse, and floor mats. The precision of his moves and his perfect muscular control were masterfully revealed through these still portraits. The angles formed by his limbs and torso were fascinating.

Books about ballet, yoga, and running seemed to jump out from the shelves. Why not help the children to see the beauty of disciplined bodily movement through geometric angles? I tucked the Thomas book into the crook of my arm, and headed for the cashier.

Viewing Angle

The bulletin board drew many thoughtful observers. I had selected 15 of the full-page pictures of Mr. Thomas that most vividly displayed different body angles, then added semicircles of white self-adhesive label material to identify the angles whose size I wanted the onlookers to estimate. I laminated the pictures, knowing that my students would be wise enough to use their hands to help them to judge angle size. I also hung up a protractor, with directions for its use in measuring angle size. The "answers" were provided under a flap of paper next to each picture.

It was exciting to see students and teachers stop in front of the display and become immersed in the presentation, often for long periods of time, and with no knowledge that they were being observed. The gym teacher asked for similar pictures to hang in the gymnasium, and I was happy to provide her with photographs of children in ballet positions. Students voluntarily began collecting and submitting action shots of football stars, wrestling matches, jazz dancers and acrobats. Some even brought in cameras to photograph each other on the balance beam and uneven parallel bars.

New Angles

Truly, they had discovered a new way to look at their world. Angle estimation conversations around the displays would often become somewhat heated, and, to the teachers' delight, would be settled with the use of a protractor. It was interesting to watch how this difficult skill was passed on voluntarily from student to student. Many reacted with surprise when they realized that it was not as hard as it had seemed when they had had to do it in their mathematics books.

It was no surprise, then, when the children's Logo work began to reflect this new area of interest. Some had just