



# ***LOGO EXCHANGE***

**Volume 14 Number 1**

**Fall 1995**

**Journal of the ISTE Special Interest Group for Logo-Using Educators**



## **Multidimensional Logo Explorations**



### ***In this issue:***

**From Two to Three Dimensions  
3-D Turtle CAD System  
Exploring Heading  
Lamp and Temperature Sensor**

**Logo Action Research  
Exploring Coordinates  
The Power of Two  
Delayed Effects of Logo**

**Editorial Publisher**

International Society for Technology in Education

**Editor-in-Chief**

Dorothy M. Fitch

**Copy Editor**

Jennifer Lindsey

**Founding Editor**

Tom Lough

**International Editor**

Dennis Harper

**SIG/Logo Officers**

Chuck Friesen, President  
Steve Sesko, Vice-President  
Hope Chaffian, Secretary/Treasurer  
Dorothy Fitch, Editor

**Production**

Kerry Lutz

**Editorial Coordinator**

Jodie Rogers

**Director of Advertising Services**

Lynda Ferguson

**Marketing Director**

Martin G. Boyesen

**Submission of Manuscripts**

*Logo Exchange* is published quarterly by the International Society for Technology in Education Special Interest Group for Logo-Using Educators. *Logo Exchange* solicits articles on all aspects of Logo use in education.

Manuscripts should be sent by surface mail on a 3.5" disk (where possible). Preferred format is Microsoft Word for the Macintosh. ASCII files in either Macintosh or DOS format are also welcome. Submissions may be made by electronic mail as well. Where possible, graphics should also be submitted electronically. Please include electronic copy, either on disk (preferred) or by electronic mail, with any paper submissions. Paper submissions may be submitted for review if electronic copies are supplied upon acceptance.

**Send surface mail to:**

Dorothy M. Fitch  
3 Derby Road  
Derry, NH 03038

**Send electronic mail to:**

Internet: 71760.366@compuserve.com

**Deadlines**

To be considered for publication, manuscripts must be received by the dates indicated below.

Volume 14, Number 3	Oct. 1, 1995
Volume 14, Number 4	Jan. 1, 1996
Volume 15, Number 1	Mar. 1, 1996
Volume 15, Number 2	June 1, 1996

**ISTE Board of Directors 1995-96**

David Brittain, President  
*Florida Department of Education (FL)*  
David Moursund, Executive Officer  
Dennis L. Ilybee, Associate Executive Officer

**Executive Board Members**

M.G. (Peggy) Kelly, Past-President  
*California State University - San Marcos*  
Connie Stout, Secretary  
*Texas Education Network (TX)*  
Barry Pitsch - Treasurer  
*Heartland AEA #11 (IA)*  
Terrie Gray, At Large  
*Chicago Unified School District (CA)*

**Board Members**

Kathy Edwards  
*Apple Computer, Inc., Santa Monica (CA)*  
Terry Killion  
*Jefferson County R1 School District (CO)*  
Paul O'Driscoll  
*Salem-Keizer Public Schools (OR)*  
Lynne Schrum  
*University of Georgia*  
Carla Schutte  
*Long Branch Elementary School (VA)*  
Gwen Solomon  
*U.S. Department of Education (DC)*  
Neal Strudler  
*University of Nevada - Las Vegas*  
Harnet Taylor  
*Louisiana State University*

*Logo Exchange* is published quarterly by the International Society for Technology in Education (ISTE), 1767 Agate Street, Eugene, OR 97403-1923, USA; 800/336-5191. This publication was produced using Aldus PageMaker®.

ISTE Members may join SIG/Logo for \$24.00. Dues include a subscription to *Logo Exchange*. Add \$10 for mailing outside the USA. Send membership dues to ISTE. Add \$4.00 for processing if payment does not accompany your dues. VISA, Mastercard, and Discover accepted.

Advertising space in *Logo Exchange* is limited. Please contact ISTE's director of advertising services for space availability and details.

*Logo Exchange* solicits articles on all topics of interest to Logo-using educators. Submission guidelines can be obtained by contacting the editor. Opinions expressed in this publication are those of the authors and do not necessarily represent or reflect the official policy of ISTE.

© 1995 ISTE. All articles are copyright of ISTE unless otherwise specified. Reprint permission for nonprofit educational use can be obtained for a nominal charge through the Copyright Clearance Center, 27 Congress St., Salem, MA 01970; 508/744-3350; FAX 508/741-2318. ISTE members may apply directly to the ISTE office for free reprint permission.

**POSTMASTER:** Send address changes to *Logo Exchange*, ISTE, 480 Charnelton St., Eugene, OR 97401-2626. Second-class postage paid at Eugene OR. USPS# 660-130. ISTE is a nonprofit organization with its main offices housed at the University of Oregon. ISSN# 0888-6970

## Contents

From the SIG-Logo President .....	<i>Chuck Friesen</i>	2
From the Editor: New Directions in Logo .....	<i>Dorothy M. Fitch</i>	3
Quarterly Quantum: Coming Around .....	<i>Tom Lough</i>	4
From Two to Three Dimensions .....	<i>Jim Muller</i>	6
What's Your Bearing? Developing Directional Concepts Using SETHEADING .....	<i>Kathryn A. Verzoni</i>	9
Cartesian Coordinates and Logo .....	<i>Marian Rosen</i>	14
Logo Action Research: Creating a Community of Teacher-Learners .....	<i>Nan Youngerman</i>	18
CLIME Notes: Council for Logo & Technology in Mathematics Education The Power of Two .....	<i>Ihor Charischak</i>	21
Turtle CAD: Computer-Aided Design in Logo .....	<i>Jim Muller</i>	24
Control Simulations (Part 1) Lamp and Temperature Sensor .....	<i>Glen L. Bull, Gina L. Bull, and Todd Kent</i>	29
Logo: Search and Research Delayed Effects of Logo .....	<i>Douglas H. Clements and Julie Sarama</i>	34

# From the SIG-Logo President

by Chuck Friesen

---

The end and the beginning of a school year allow us an opportunity to reflect upon what has just been accomplished and to focus our energies on the new challenges ahead. As we think about the Logo environments in which we will be working, it seems appropriate to reflect upon the comments of classroom teachers in their Logo environments.

The Lincoln Public Schools, Nebraska; have provided Logo environments for elementary school students for over 12 years. Teacher input has been used to modify and adjust the program during this time. Teachers have been encouraged to share stories about the influence Logo has had upon their students. Several such responses follow:

"Students become very aware of the importance of following directions and giving clear directions."

"The students are always ready to help each other with a problem."

"Students enjoy Logo and certainly learn geometric concepts."

"Logo seems to 'bring out' some students with learning problems. That's neat!"

"Students with learning disabilities can be as successful as the average or above average student. Students feel very good about printing their work. 'Look what I did!' could always be heard in the computer lab."

"I have seen many students become critical thinkers in order to solve problems."

"I have a student who has gained respect and stature in the classroom because he seems to know what to do with a computer and he teaches others to do the same. This youngster has long been the brunt of criticism and tricks, but that has diminished appreciably...."

"The shyest child in our room was the best in using Logo. This really helped her self-concept. She wanted to show everyone what she could do."

"The thinking skills it promotes are excellent."

"The smiles of success when their pictures are printed are evidence of personal pride in their work."

These comments make several points:

1. All students can benefit from working with Logo. Special education students can be successful, if provided an appropriate Logo environment. And students who may not otherwise be successful in school can make significant Logo contributions. This serves to remind us never to underestimate a student's potential.
2. Problem solving and thinking skills can be practiced and enhanced by working with Logo.
3. Geometry concepts are presented and reinforced as students work with turtle mode. Students working with Logo encounter many other mathematical concepts, including coordinates and variables.

As we anticipate our next Logo experiences, it is important for us to reflect upon what the Logo environment can do for students and teachers. Indeed, there are many benefits beyond those few listed above. If we believe that all students can benefit from working with Logo, and if we can articulate the many benefits of working with Logo, then we are in a position to have a significant impact upon the students and teachers with whom we work.

SIG-Logo, the ISTE Special Interest Group for Logo-Using Educators, and *Logo Exchange* remain committed to providing leadership and support to those working to achieve Logo goals. I am hopeful that each of us will have a number of Logo success stories to share throughout this school year. ▲

**Chuck Friesen** is the Director of Instructional Technology in the Lincoln Public Schools, Nebraska. He can be reached at 402/436-1629 or via e-mail at: cfriesen@lps.esu18.k12.ne.us



# From the Editor: New Directions in Logo

by Dorothy M. Fitch

---

With this volume of *Logo Exchange*, I begin my role as editor. I am excited about the prospect, yet filled with the sense of responsibility it entails. How can I help this journal reflect all that is going on in the Logo community, how people are using Logo, how they are thinking with Logo, the new trends that are emerging? A subtle theme of this issue is that of headings and positions, which can help us all seek new directions.

First and foremost, I want *LX* to offer fun, easy-to-use ideas that you can try in your classroom tomorrow. Logo novices and experienced users alike should find a wealth of ideas to investigate, contemplate, share, discuss, and absorb.

At NECC '95, members and officers of SIG-Logo discussed how we might get more members actively involved. We would like to see new participants in our activities and in *LX*. SIG-Logo offers a wealth of resources, both in its membership and in its journal. We hope that you will encourage your colleagues to join SIG-Logo.

To help open the SIG-Logo doors a little wider, we want to include more articles by our members in *LX*. Starting with this volume, we will continue to bring you ideas and activities from familiar writers, but contributions from regular columnists may not appear in every issue. There are many new names and faces eager to write for *LX*, and we'd like to hear from even more of you.

I would first like to thank Sharon Yoder, my predecessor as *LX* editor, whose help, support, and years of hard work have made this transition easier than I ever imagined.

Next, I would like you to meet a few new Logo enthusiasts who will be contributing their thoughts and ideas from time to time. You may already know them, as they have been part of the Logo community for years.

**Jim Muller**, who has a long history with Logo, is the ever-popular moderator and resident guru of the Logo Forum on CompuServe. Because he can

explain just about anything to anyone, I have asked him to contribute to *LX*. His "no threshold, no ceiling" ideas include both on and off computer activities. In this issue he deftly carries one concept from beginning to advanced levels in two related articles. Don't miss his 2-D and 3-D activities!

**Nan Youngerman** will be reporting on the Logo Action Research Collaborative, where teachers are researchers in their own classrooms.

**Ihor Charischak**, founder of the Council for Logo & Technology in Mathematics Education, will share some of his favorite math activities. If you are not already a member, consider joining CLIME!

You will also continue to hear from some old favorites: **Tom Lough** makes us ponder with wonder about how Logo affects us all; **Glen** and **Gina Bull** stretch our ideas of what we can do with Logo; **Robert Macdonald** brings us a wealth of good ideas; **Dennis Harper** updates us on the international Logo scene; and **Doug Clements** and **Julie Samara** keep us current with Logo research.

Additional contributors in this issue offer fresh approaches to the "tried and true." **Kathryn Verzoni** introduces fun activities for exploring headings, while **Marian Rosen** shares teaching ideas for coordinates. Both give us ideas we can use immediately with our students.

Come share your latest Logo passion with our readers. What excites you and your students? What Logo successes can serve as models for others? Ask me for a copy of our *LX Submission Guidelines*. Don't worry about being an accomplished writer; the most important step is to take action. We can help with the rest. I hope to hear from you soon.

**Dorothy Fitch**, *LX* Editor  
3 Derby Road, Derry, NH 03038  
603-425-2010  
Internet: 71760.366@compuserve.com  
CompuServe: 71760,366



# Quarterly Quantum: Coming Around

by Tom Lough

---

The ability of Logo to engage is a perpetual delight. The “accidental” discoveries, the insights, the often surprising results—what a marvelous collection of computer code.

As I was preparing this column—the first under the leadership of Dorothy Fitch (Welcome, D!)—it seemed appropriate to have in mind some significant lesson to offer or a major point to make. But somehow the right ideas eluded me.

What to do? I had a vague idea about using something with the random command to explore how the turtle can find hidden “food” on the screen. So I began messing about.

First, I set up the location of the food at the coordinates of  $x=80$  and  $y=80$  with the following procedure:

```
to food
output [80 80]
end
```

Little procedures such as **food** are easy to write and simple to use. Because of the output reporter, you don’t need any quotes or colons (dots) to get the values out.

Next, I wrote a procedure to make the turtle face toward the food (perhaps it has a strong smell), turn in a random direction to the left or right (but not more than 90 degrees, so that it is still facing the food—sort of), and then move forward. (Note: Some versions of Logo may require **seth** instead of **setheading**, **toward** instead of **towards**, or **towardspos** instead of **towards**.)

```
to move
setheading towards food
right (random 180) - 90
forward 10
move
end
```

Admittedly, the **move** procedure was in rather rough form. I had to interrupt the procedure (Apple-S, Ctrl-S, or Ctrl-G usually works for this). And  $(\text{random } 180) - 90$  was not “exactly” correct. But it gave me something to play with.

It was fun to see how the behavior of the turtle changed if I changed the coordinates of the food or if I changed the size of the input to **forward** in the **move** procedure. Perhaps it was this technodoodling that gave rise to the idea that popped into my head next.

How about arranging things so that the turtle deliberately turns nearly transverse to the most direct path to the food? In other words, the turtle does not take any direct path to the food but moves nearly sideways instead.

After a little thought, the following procedure suggested itself (some versions of Logo use **if** instead of **ifelse**).

```
to sidle :distance
setheading towards food
ifelse (random 2) = 1 [left 90 right
  (1 + random 5)] [right 90 left (1 +
  random 5)]
forward :distance
sidle :distance
end
```

If you want a neat surprise, predict what happens if you type **sidle 10**, then try it. Next, experiment with different input values to **sidle**. Can you figure out some general rule to describe what is happening?

The turtle sidling about on the screen reminded me of several of my students. Even when the way to a learning goal was clear, they would choose (sometimes even obstinately) a deliberately transverse path. In doing so, they blazed unexpected trails with surprising aspects to them. But they also made progress toward the learning goal, just as the turtle continued to make progress toward the food.

This realization affirmed for me the leeway I tried to extend to the students when I could. Sure, their progress was herky-jerky and somewhat inefficient. But they learned in a way that was robust and legitimate for them.

And in the end, like the turtle, they arrived in the vicinity of their goals.

This is a good time of year to reaffirm our faith in our students: that they are capable of learning, and that they will come around right in the end.

**FD 100!**



**Tom Lough**

Founding Editor

Box 394

Simsbury, CT 06070

Internet: 70020.223@compuserve.com

CompuServe: 70020,223

P.S. If you run the **sidle** procedure and observe the final results, can you find a rule to describe the size of the resulting figure? I'd be interested in your analyses or, even better, those of your students!

# THE RUSH IS ON!



Today, the mother lode of knowledge is the "network of networks"—the Internet.

In *Way of the Ferret—Finding Educational Resources on the Internet*, network explorer and guide Judi Harris shows you how to ferret out the information you need—original

source documents, free and inexpensive software, up-to-the-minute news and discussions, cooperative classroom projects, and invaluable personal contacts.

Learn to use information mining tools, including Telnet, FTP, and Gopher. Reach out to colleagues and remote classrooms through e-mail, listservs, and newsgroups.

More than a technical manual on telecommunications, *Way of the Ferret* is a guide to practical classroom and personal use of the Internet, presented with skill and humor by one of the most active authors in educational technology. *Way of the Ferret* is based on Judi Harris's "Mining the Internet" column in *The Computing Teacher* journal, with information updated to stay current with the constantly evolving Internet environment.

Order your copy of *Way of the Ferret*, and stake your claim to the information gold mine.



International Society for Technology in Education  
Customer Service Office  
180 Davidson Street, Eugene, OR 97401-3228 USA  
Phone: (504) 534-5111 Fax: (504) 534-5179  
Internet: [custserv@iste.org](mailto:custserv@iste.org)

The phrase "Mining the Internet" was borrowed with permission from Computing Service personnel at the University of California, Davis.



# From Two to Three Dimensions

by Jim Muller

---

In the fall of 1982, a reporter from the *Dallas Morning News* visited the school where we were working on pilot programs for K-1 and 3-4 grade Logo programs. David Real, the reporter, interviewed a number of the children, including 5-year old Jamie.

"It makes fun things," she said. "It's a fun machine for drawing and colors."

She knows the computer is smart, but she is even smarter.

"Why?"

"Because I can roller skate," Jamie said firmly.

This brought a broad grin to David's face as he recorded his conversation with Jamie. As he left he commented on how these children had a better sense of what they were doing at the computer than most of the people at the newspaper.

The school had two computers on loan, with classes of 14 to 18 students all eager to explore these marvels of technology. We had no choice but to develop learning activities that could be explored on and off the computer in various ways. In essence, we had to find ways to teach the turtle to roller skate.

That's what we'll be doing in this article—exploring multidimensional learning activities that young people can explore both on and off the computer.

We had, of course, gone through all the body geometry activities and games. Blocks and plastic shapes also provided a three-dimensional look at what the children created on the screen. But these activities did not really challenge their imaginations.

## The soccer ball challenge

One of the first activities we discovered arose from a young fellow from Venezuela. Carlos did not speak English very well and was having trouble relating to the activities of American

youth. When we discovered that Carlos had an enduring love for the game of soccer, we felt we had finally found the key to getting him actively involved with the computer class.

We challenged the class to split into two soccer teams. Then, which team would be the first to recreate the pattern of the soccer ball on the screen? The students divided themselves into the boys against the girls.



The basic soccer ball pattern is a pentagon surrounded by hexagons. That sounds simple enough. But that pattern only exists in three dimensions—only on a round ball. It cannot be created easily on the computer screen using turtle graphics.

It took about 30 minutes or so until the girls' team figured out that the pattern they created on the screen had to be printed and folded to create the soccer ball pattern.



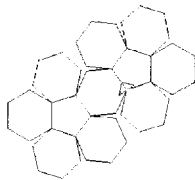
```
to soccer :side
pentagon :side
repeat 5 [hexagon :side forward :side
right 72]
end
```

```
to pentagon :side
repeat 5 [forward :side right 72]
end
```

```
to hexagon :side
repeat 6 [forward :side left 60]
end
```



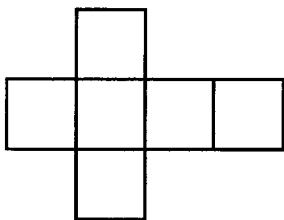
After printing a number of patterns, the girls pasted them together to make their soccer ball. Of course, pasting all those separate patterns was something of a chore. So the next task was to expand the pattern on the screen. Finally, a **move** procedure was added.



```
to move :side
repeat 2 [forward :side right 72]
repeat 3 [forward :side left 60]
end
```

### More 3-D objects

The soccer pattern sparked an interest in creating three-dimensional objects. The children began with a box. This seemed simple enough: create a line of four squares crossed by three more squares.

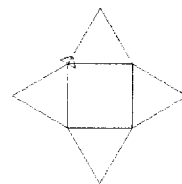


```
to box :side
repeat 4 [square :side right 90 forward
:side left 90]
left 90
forward :side * 3
right 90
forward :side
repeat 2 [square :side back :side]
square :side
end

to square :side
repeat 4 [forward :side right 90]
end
```

Boxes, of course, led to pyramids. Pyramids started discussion about the Egyptians and their

innovative use of geometry, surveying, weights, and measures—but that's another story.



```
to pyramid :side
right 30
repeat 4 [tri :side right 60 forward
:side right 30]
end
```

```
to tri :side
repeat 3 [forward :side right 120]
end
```

### Something new to ponder...

The pyramid added a new twist to our work with three-dimensional objects. The pyramid procedure drew four triangles, which, when folded, created five sides. When drawing the box and the soccer pattern, each shape had been created specifically. Within the pyramid procedure, there was no procedure to create the square. It just appeared.

Why?

As it turned out, the children had considered anything that was not specifically created as empty space. Only after the pyramid was printed and folded did they realize that the resulting square was as real as the rest of the drawing. So they immediately went back to the boxes procedure to try their amazing new theory.

After some experimentation, the result was:

```
to box :side
repeat 4 [square :side right 180 forward
:side right 90]
forward :side
square :side
end
```

In the process of exploring these folded paper exercises, the children discovered a new word: polyhedron. To them, it sounded funny. But it also led them to explore other solid objects they could print and fold.



## Learning gains

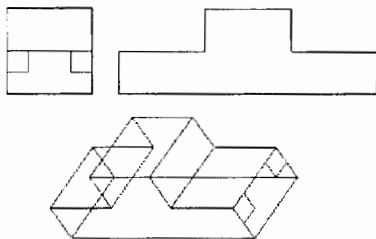
What did these children learn about three-dimensional geometry? We never considered *what* they learned nearly as important as their growing ability to visualize the transition between two- and three-dimensional objects—the ability to look at a solid object and then unfold it to recreate the planes on the screen.

Jamie and her friends in kindergarten developed their own sense of two- and three-dimensional worlds. We divided the third- and fourth-grade computer classes into groups of four or five students. These smaller groups would rotate among several learning centers to examine a solid object and draw the planes on paper, create the object on the two-dimensional screen, print and fold the resulting object, and then use blocks and other objects to create and explore new three-dimensional shapes.

What did they really gain from all of this? We could see that it gave them a new way to look at the space around them. I have often wondered what went through their minds as they later entered high school math classes.

## More explorations

When I talked about these exercises with my son and his junior high friends, they wondered if they could use Logo to create, rotate, and examine three-dimensional objects as engineers do on sophisticated computer-aided-design systems. This proved to be a bit more involved than folding paper. Rather, it gave the group an in-depth look at the use of property lists to create objects such as a true econo-box automobile. (See also in this issue the article “Turtle CAD: Computer-Aided-Design in Logo.”)



These procedures are available on the CompuServe Logo Forum or from me via e-mail. I will be happy to give you some examples and an explanatory article. ▲

**Jim Muller** has had a lifelong interest in translating various technologies into understandable and persuasive programs—as a Scout leader, as a U.S. Air Force instructor, and as a corporate communications executive for high technology companies, including Texas Instruments Incorporated. After introducing TI Logo in April of 1981, Muller and his son organized the first Logo users group, the Young Peoples' Logo Association. What started as eight young people exploring Logo around a Ping-Pong table in a Richardson, Texas, garage, grew into a worldwide 6,000-member organization. Among other things, the organization published *1,2,3 My Computer and Me* and *The Turtle's SourceBook*. Both of these books are now being expanded for use with current versions of Logo. In 1985, the YPLA merged with CompuServe, where it became The Logo Forum. Today, Muller is a computer training and marketing consultant in the Dallas/Fort Worth metroplex. He can be reached on the Internet at 76703.3005@compuserve.com or on CompuServe at 76703,3005.

# What's Your Bearing? Developing Directional Concepts Using SETHEADING

by Kathryn A. Verzoni

---

"Caterpillar functioning normally, Comrade Captain," Borodin reported.

"Excellent. Steer two-six-zero, helm," Ramius ordered.

"Two-six-zero, Comrade." The helmsman turned his wheel to the left.

(Tom Clancy, *The Hunt for Red October*.)

Whether at sea, on land, or up in the air, the use of bearings in wayfinding is certainly an often-used skill. The activities presented in this article were designed to develop the concept of bearing and its relationship to the Logo primitive **setheading** in third- through sixth-grade students.

I've always found students' difficulties in distinguishing between the primitives **setheading** and **right** or **left** turn fascinating. Although right turn is relative to the turtle's direction and **setheading** is absolute, many of our younger students traditionally confuse **setheading** as just another way to say right turn. Connecting **setheading** to the concept of bearing has provided the key to developing their abilities to make the distinction.

Directional concepts are introduced with the paper and pencil activity called "Find the Treasure" (Figure 2).

First, I distribute bearing guides (Figure 1) to the students and, given due north, have them find bearings in the classroom. I then review map scales and have the students determine a few distances and directions on the treasure map for

practice. Finally, the students are set loose with the clues to determine where the treasure lies.

After this activity I introduce the Logo primitive **setheading**. The special microworlds I have developed (Figures 3 and 4) challenge learners to program the turtle (in immediate mode) to visit a number of locations on the map. Students are encouraged to use their bearing guides by placing them up against the screen with zero pointing straight up. Depending upon age, experience, and ability, students require from five to fifteen minutes to navigate through each map.

The paper and pencil activity called "Escorting the Governor" (Figure 6) requires students to determine bearings and distances in order to plan a governor's hypothetical speech-making trip. The activity further develops connections between real-life use of directions and distances and primitives relating to such in the Logo environment.

Finally, in the Logo microworld called "My Bearings" (Figure 5), students create their own treasure maps using **setheading**, **forward**, **back**, **pu**, **pd**, **setc**, and the special commands provided in the microworld. The following code was written for *MicroWorlds Project Builder* but can be easily translated for other Logo environments.

"Quiet FD functioning normally, Greta T. Grader, IV," Turtle 0 reported.

"Excellent," Greta coded.

"I DON'T KNOW HOW TO Excellent," Turtle 0 retorted.

Frustrated, Greta typed back, "TELL 1 SETH 260," and hit the return.

Turtle 1 immediately turned left fifty-five degrees from his bearing of three-one-five.

"Ha, I like being the boss," Greta mused as the two minute warning bell chimed.

## Program for "My Bearings"

```
to create.map
page2
end
```

```
to see.directions
page1
end
```

```
to island
tl,
setsh 0
pd
setc 32
setpensize 5
shoreline
inland
end
```

```
to shoreline
ht
repeat 15 [forward 3 right 7]
repeat 22 [forward 2 right 4]
repeat 22 [forward 2 left 2]
repeat 15 [forward 3 right 7]
repeat 15 [forward 2 right 6]
repeat 5 [forward 5 left 5]
repeat 13 [forward 3 right 4]
repeat 5 [forward 4 left 3]
end
```

```
to inland
setc 33
pu
right 90 forward 10
pd
fill
pu
st
end
```

```
to ocean
setbg 93
end
```

\* create a treasure chest with shape 13 \*

```
to treasure
tl,
setsh 13
pe
stamp
pu
end
```

\* create a ship with shape 14 \*

```
to ship
tl,
setsh 14
setpensize 1
setc 9
pd
end
```

▲

**Kathryn Verzoni** is a computer technology and mathematics teacher at West Point School on the United States Military Academy base. She is involved with research regarding young adolescent learner interactions with Logo and Prolog programming environments and possible uses of such environments for developing conditional reasoning, algebraic reasoning, and mathematical problem-posing skills.

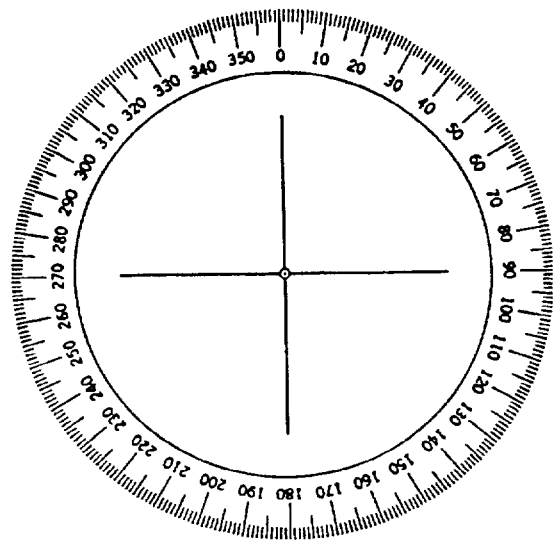


Figure 1. Bearings Guide

From the *Right Angle* of the Jasper Woodbury Series developed by the Learning Technologies Center at Vanderbilt University.

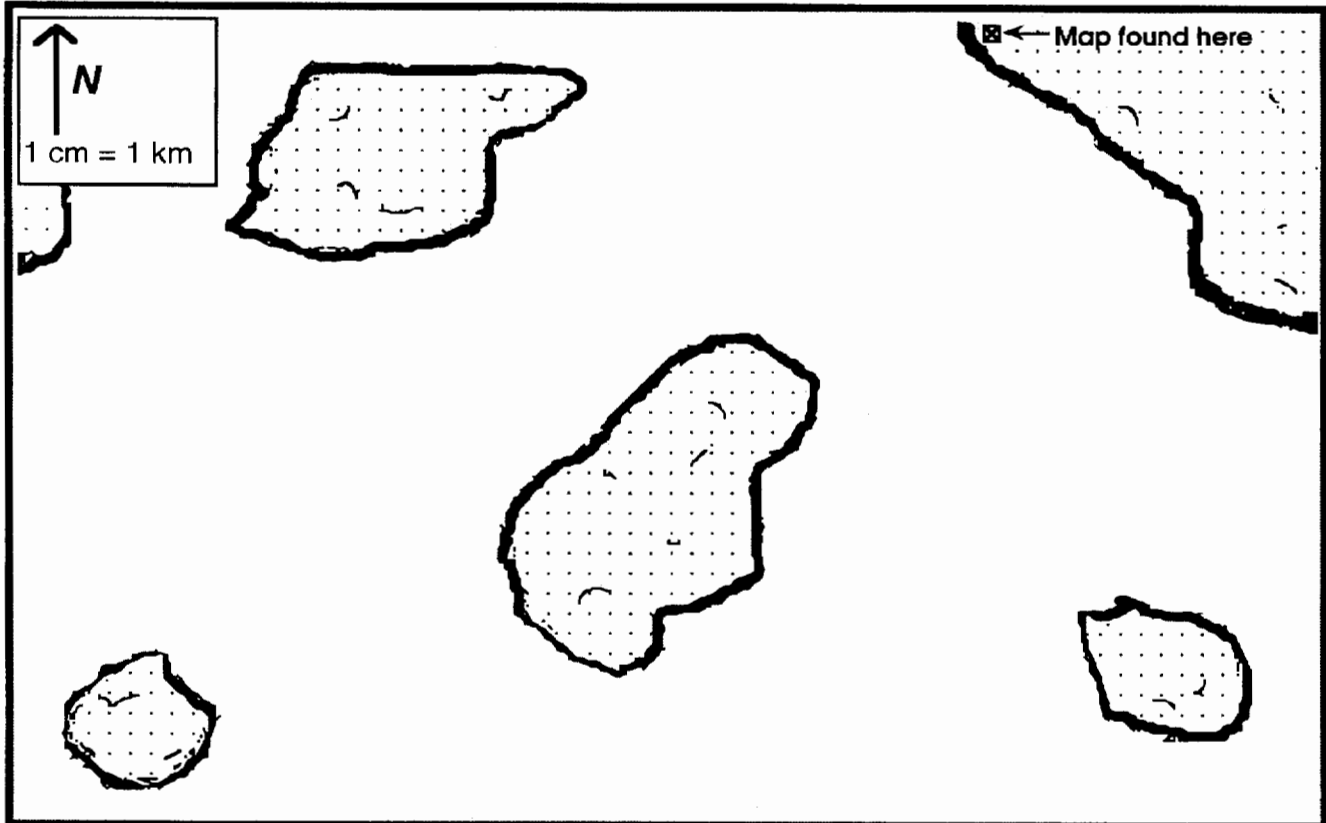
# Find the Treasure

Verzoni, West Point School, 4/93

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Section: \_\_\_\_\_



Tony and Kenisha find a treasure map on a deserted beach.  
Help them find the treasure.

## Clues

1. From the location of this map, sail at a bearing of 210 degrees for 5 km until you reach an island.
2. From the southern-most point of that island, sail at a bearing of 260 degrees for 5.5 km until you reach another island.
3. From the northern-most point of that island, sail at a bearing of 7 degrees for 6 km until you reach a third island.
4. From the eastern-most point of that island, sail at a bearing of 130 degrees for 11 km until you reach a fourth island.
5. From the western-most point of that island, sail due north for 7 km.
6. You will find the treasure hidden on the beach in a nearby cave.

Figure 2





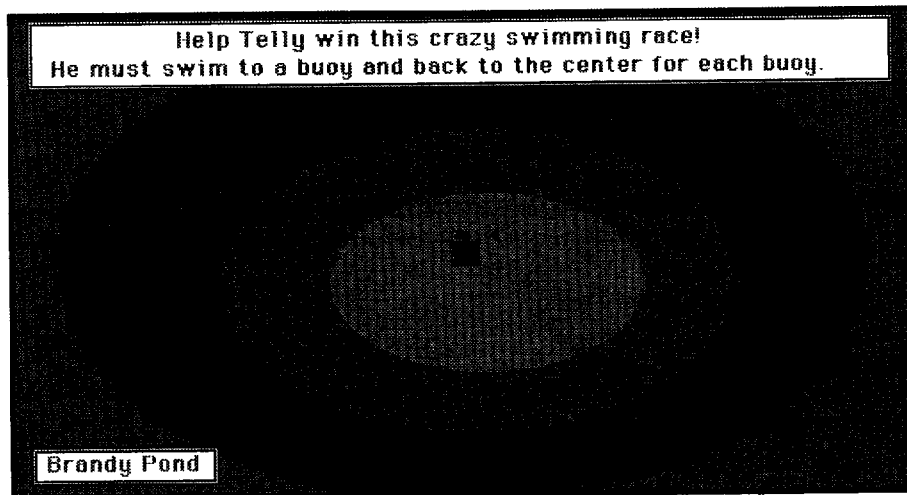


Figure 3. Swimming Race

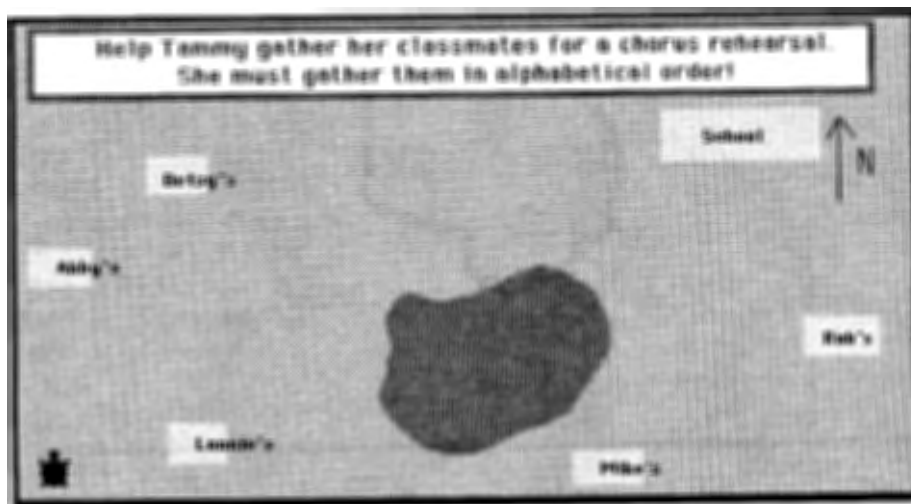


Figure 4. Chorus Rehearsal

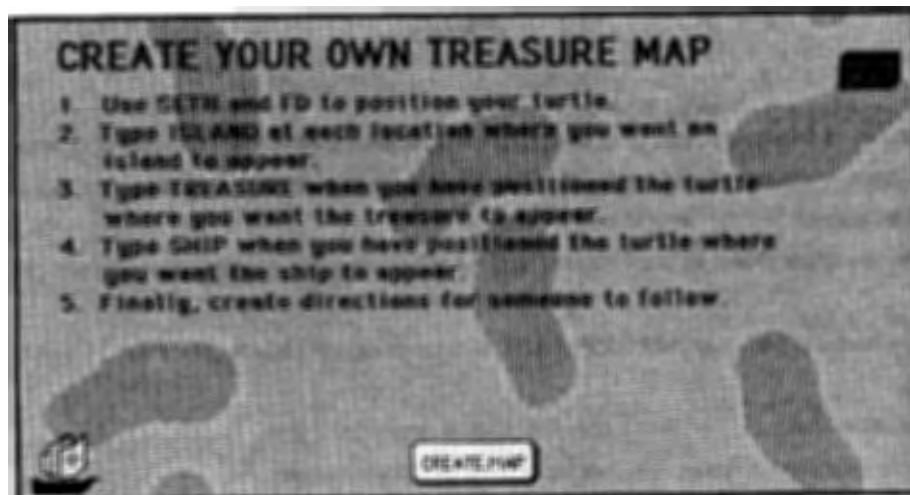


Figure 5. My Bearings

# Escorting the Governor

Verzoni, West Point School, 4/94

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Section: \_\_\_\_\_

*Pretend that you are an ace helicopter pilot and that you must fly the governor from Albany to four different cities in New York State. Here are your orders.*

1. From **West Point**, fly at a bearing of \_\_\_\_\_ degrees for \_\_\_\_\_ miles until you reach **Albany**.
2. Pick up the governor in **Albany** and then fly at a bearing of \_\_\_\_\_ degrees for \_\_\_\_\_ miles until you reach **Ithaca**.
3. After the governor's speech in **Ithaca**, fly at a bearing of \_\_\_\_\_ degrees for \_\_\_\_\_ miles until you reach **Plattsburgh**.
4. After the governor makes his speech in **Plattsburgh**, fly at a bearing of \_\_\_\_\_ degrees for \_\_\_\_\_ miles until you reach **Buffalo**.
5. After the governor makes his speech in **Buffalo**, fly at a bearing of \_\_\_\_\_ degrees for \_\_\_\_\_ miles until you reach **Corning**.
6. Finally, fly the governor home at a bearing of \_\_\_\_\_ degrees for \_\_\_\_\_ miles until you reach **Albany**.

*Uh oh! Your orders are incomplete. Use the map to determine bearings and distances. Don't get lost.*

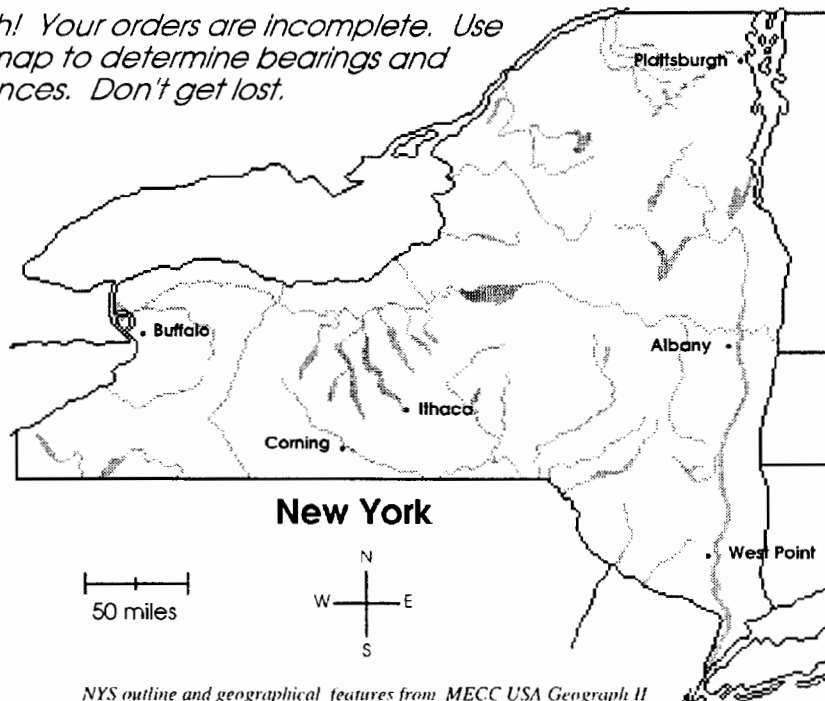


Figure 6



# Cartesian Coordinates and Logo

by Marian Rosen

---

There are at least three ways of thinking about moving our bodies through space. In the first way, we visualize ourselves as if we were moving through a maze at ground level. We leave home, go forward three miles, turn right, and continue two miles. In the second way, we see ourselves from above on a map and we travel east on High Road for three miles, go Southeast when the road branches, and continue two miles to the School. In the third way, we know all the places so well that we move directly from home to the Red Barn where the road branches and then to the School.

## Getting around in Logo

A Logo turtle can move in all three ways. The first involves moving **forward**, **back**, **right**, and **left**; the second uses **setheading** and **forward**; and the third uses Cartesian coordinate commands: each pixel has a name, which is an ordered pair. The computer knows each point so well that it makes the turtle jump directly to the right spot.

Most versions of Logo have three coordinate commands—**setx #**, **sety #** and **setpos(ition) [# #]** (or **setxy # #**)—that move the turtle around the screen. The center of the screen is the origin. The command **home** is actually equivalent to **setx 0 sety 0** or **setpos [0 0]**. Try it!

It is possible to use **setx**, **sety**, and **setpos(ition)** to draw entire pictures. This may not be the best way to draw, but it is a terrific way to teach coordinates and to have students apply their knowledge.

If your version of Logo does not have **setpos**, you can define it as follows:

```
to setpos :list
  setxy first :list last :list
end
```

If you are using *PC Logo*, use the name **setxy** instead of **setpos** in these examples.

## Investigating coordinates

The project described here has been used successfully by third- through eighth-grade students. You can make the project easier or harder. To make it easier, have students draw only in the upper right-hand quadrant and use only **setx** and **sety**. For more complexity, work in all four quadrants and use **setpos(ition)** to draw diagonals.

Students begin by learning or reviewing coordinates in math class. When they get to the computer, there are several ways to practice the **setx**, **sety**, **setpos** commands. The simplest is to give each pair of students a small wad of masking tape. The first kid puts the wad on the screen; the second one uses only **setx** and **sety** to move the turtle under the tape. Then they switch places. Challenge the kids to get to the tape in the least number of moves. Let them play sometimes with **penup** and sometimes with **pendown**. After they are comfortable with **setx** and **sety**, have them play the same game using **setpos**.

It is good to change the turtle shape to a symmetrical costume that does not have a head or a tail, a top or a bottom. Square and circle shapes work well. This helps students of all ages break away from the idea of forward and back. It develops the idea that you are moving the turtle to a point on the screen that has a name. For older kids, the turtle can be a single pixel. This is somewhat abstract, but it is a nice way to reinforce the idea of a point.

## Planning a project

After students have mastered the tape game, they begin to plan their project on graph paper. I've found it helpful to provide graph paper that corresponds to the screen.

A low tech, fast way to do this is to start with a piece of quarter-inch graph paper. Figure out how many turtle steps tall and wide your Logo screen is. Cut out a rectangle from the graph

paper that matches your screen. For instance, if your graphics screen or window is 220 by 480 turtle steps, cut out a rectangle that is 22 rows by 48 columns. (Each square, therefore, is 10 steps by 10 steps and students should count by tens when using the paper.) With a marker, draw over X and Y axes. Tape the grid to a regular sheet of paper and photocopy.

Students can work individually or in pairs. They draw their initials or a word on the graph paper. I reserve the right to okay each graph before the students go to the computer. The graphed picture serves as a contract between the students and me about what they are going to do. It gives me a chance to make sure they are doing a project that really excites them and that fits their level of understanding.

### Tips for students

- It is easier to work in the positive, positive quadrant than in all four quadrants.
- It is easier to make a word that goes straight across the page than on a diagonal.
- It is easier to make two initials than to write out MIGHTY MORPHIN POWER RANGERS.
- It is easier to stay on the lines and make S's or R's that are squared off than to use diagonals, which require **setpos**.

Kids who need or want diagonals begin to appreciate the power of **setpos**, and you may find this a good time to give them a little information about vectors.

You'll find that you have to stress that the turtle needs to know only the starting and ending point of each line segment. It is helpful to mark these with dots. The picture will take on the look of a connect-the-dots page. This is good because most kids have connected dots sometime in their past and this project builds on that knowledge. They know from that early experience that rounded shapes need more dots than straight lines, and this project helps them to understand why that is true.

### At the computer

After the graph has been approved, students use it as a map to count the X and Y coordinates for each dot and translate these into the appro-

priate **setx**, **sety**, and **setpos** commands. They make a procedure for each letter and then write a **master** procedure that combines the letter procedures.

Obviously, many kids could draw with **setx** and **sety** without using a graph or a map, but for this project I argue that it is better to have one. My goal is to get them to understand how Cartesian coordinates really work. Having them rigorously counting and copying their map, reinforces this skill.

You will find that even kids who understand Cartesian coordinates and who do well on the tape game get confused when they start applying their knowledge. By insisting on a map of their project, there is a reference point for what they are trying to do and for being sure that they don't give up at the first obstacle and do something easier just to finish fast.

### The finished product

Why should kids want to do this project? Well, some kids just like "mathy" things and enjoy making the coordinate system work for them. But all kids like the flashy creative finish to their projects. Here's the fun part!

First, make sure that all commands that would reset the graphics or set pen colors are removed from the **master** procedure. What happens next depends on your version of Logo. If you have a turtle whose pen can draw in only one width, try the following procedure (some versions of Logo use **pc** or **setpc** instead of **setc**):

```
repeat 100 [setc 5 master setc 4 master
  setc 14 master]
```

or the following, which lets the computer pick the colors randomly:

```
repeat 100 [setc random 256 master]
```

Be sure to try these flashing lines against different color backgrounds.

If you're working with a Logo that has a **setpensize** (e.g., LCSi's *MicroWorlds* or Terrapin's *Logo PLUS for the Macintosh*) or a **setwidth** command (e.g., *PC Logo*), you can play not only with the colors but also with the width of

the pen! This can lead to some spectacular effects. Try this:

```
to flashit ; for MicroWorlds
setpen size 100 setc 19 master
setpen size 80 setc 17 master
setpen size 60 setc 15 master
setpen size 40 setc 13 master
setpen size 20 setc 11 master
setpen size 1 setc 9 master
end
```

```
to flashit ; for Logo PLUS
setpen size 100 100 setpc 4 master
setpen size 80 80 setpc 5 master
setpen size 60 60 setpc 6 master
setpen size 40 40 setpc 7 master
setpen size 20 20 setpc 8 master
setpen size 1 1 setpc 9 master
end
```

```
to flashit ; for PC Logo
setwidth 100 setpc 1 master
setwidth 80 setpc 2 master
setwidth 60 setpc 3 master
setwidth 40 setpc 4 master
setwidth 20 setpc 5 master
setwidth 1 setpc 6 master
end
```

Varying the decrement on the pen's size gives you bands of different widths. Students can use the monochromatic colors as in the previous example or have rainbow, alternating, or dozens of other effects.

When students finish with the programming part of this project, they could draw a background picture (the *MicroWorlds* paint tools are handy for this).

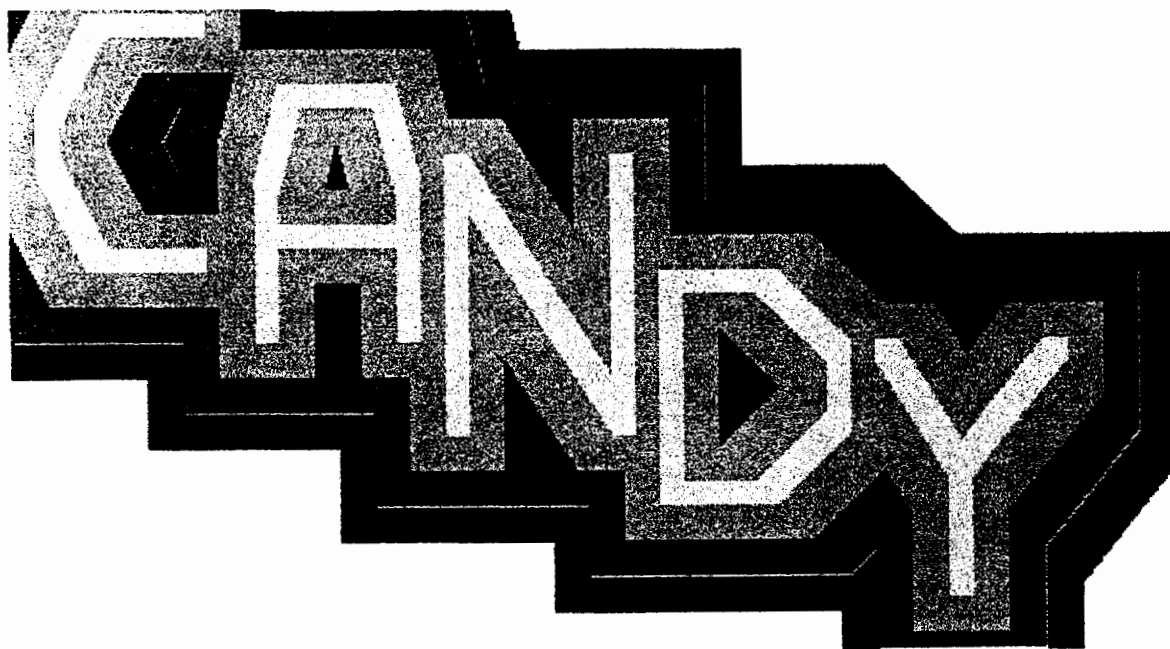
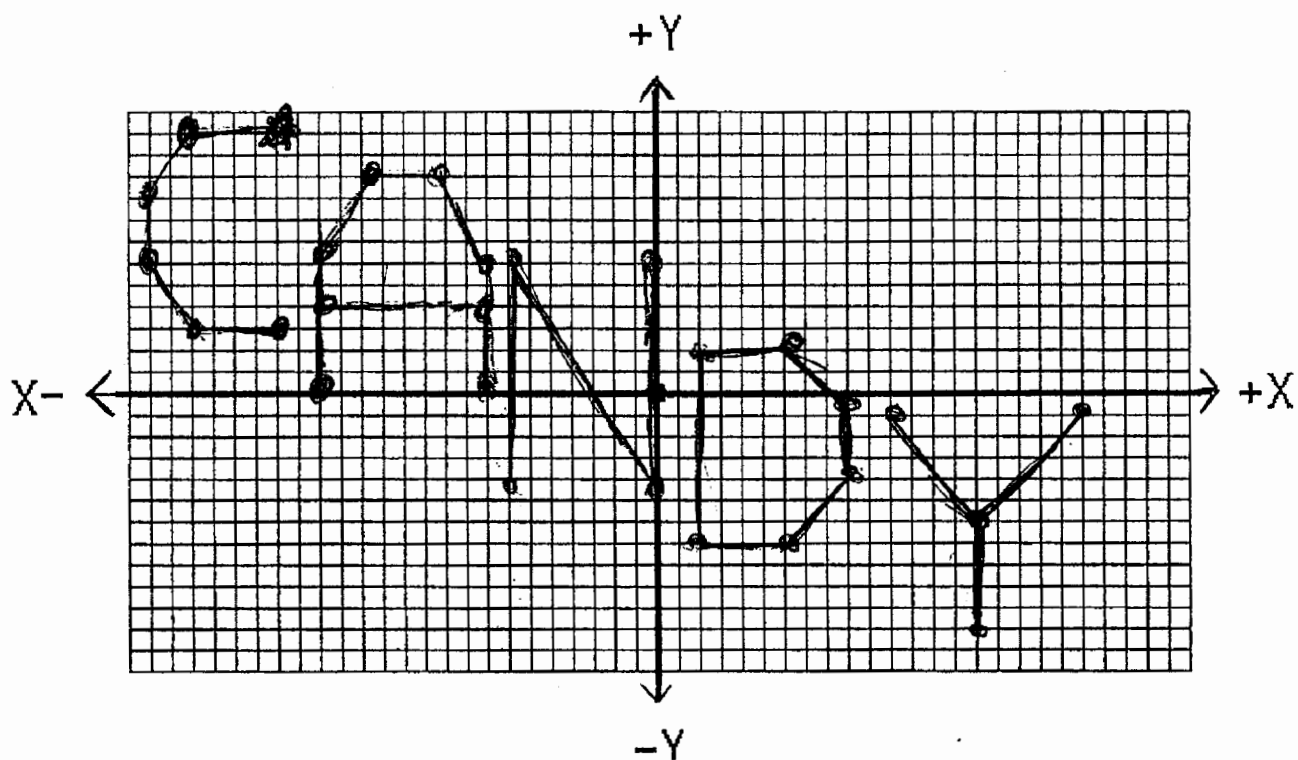
One student programmed the word COOL to flash over a background that looked like an abstract of Superman's cave. Another programmed PENGUINS to flash over a picture of the team's logo. Another drew pictures of candy canes and lollipops and flashed CANDY. The possibilities are endless and creative! ▲

**Marian Rosen** is the Instructional Technology Coordinator (ITC) at Conway Elementary School in Ladue Schools, St. Louis, MO. She can be reached at 9900 Conway Road, St. Louis, MO 63124 or via e-mail at mbrosen@oui.com



Sample of student work





# Logo Action Research: Creating a Community of Teacher-Learners

by Nan Youngerman

---

Ten years ago I was a participant in the Madison Metropolitan School District Classroom Action Research Project for kindergarten through twelfth-grade teachers. I was an experienced classroom teacher eager to explore problems that fourth and fifth graders encountered when using Logo. I wanted to increase my understanding of student technology use.

I read every magazine article I could find, talked to people within the Madison area, and tried to make connections between exemplary teaching and learning practices and student computer use. I became aware of an emerging community focused on exploring what children were learning, specifically with Logo and computers. I attended Logo '85 at MIT and met teachers from around the country who shared my curiosity and interest in the use of Logo by children. Some of my Madison, Wisconsin, colleagues attended the summer Logo Institutes led by Dan and Molly Watt and others. These summer immersion programs contributed to my awareness of an increasing number of teachers informally exploring the value of teaching and learning with Logo.

## What are students learning?

At that time Watt and Watt were frequently asked by teachers: "Is there any research I can cite to convince my school board (principal, superintendent, math supervisor, or parents) that Logo is valuable for students?" My colleagues and I were convinced that students were learning important things, but didn't know how to articulate what was happening. Watt and Watt turned the question back to teachers, asking: "What are your students learning, and how do you know?"

Despite strong convictions about Logo's worth, based on their students' work and pride in accomplishments, Watt and Watt reported that teachers were often vague in their answers. Teachers

expressed a need to become more knowledgeable and articulate about what they felt to be the benefits of Logo experiences for their students beyond the obvious and insufficient observation that students liked it (Watt and Watt).

## Budget issues come into play

The need to document what students are learning and how teachers know continues today. The question has greater significance as budgets tighten and school boards sometimes ask why students need computers at all. Schools are no longer thinking about one \$50 software package for four or five computers, but more likely a network version costing \$1,500 that might serve fifty or more school computers. Larger school districts may need to equip 50 or more schools. The stakes have increased considerably as communities face budgetary decisions and leaders question how investing hundreds of thousands of dollars in technology programs will benefit student learning.

Many teachers feel as though they are in a vise, squeezed tight by budgetary pressures and their own goals of fostering student growth through practice that they believe is rich and fruitful. Teachers face an ever-increasing need to be supported in a culture that enables them to deepen their understanding about the following:

- how children learn
- methods to improve their teaching practices, and
- integration of technology into academic areas.

## Logo Action Research Collaborative

The national Logo Action Research Collaborative (LARC), established in 1990, is an example of such a culture. It involved approximately one hundred teachers in grades K-12 in nine differ-

ent school districts from Boston, Brookline, and Concord, MA; Bellevue, WA; Brattleboro, VT; Chapel Hill, NC; Chicago, IL; Ladue, MO; and Madison, WI. Its purpose, according to Watt and Watt, was to support experienced teachers in the following activities:

- critically examining their practices
- engaging in collegial reflection and dialogue
- increasing their content knowledge of Logo
- developing methods for assessing student learning
- carrying out an action research project
- revising, improving, or developing their teaching practices
- developing more authoritative professional voices
- participating in peer support to research by colleagues.

Every word in the name “Logo Action Research Collaborative” is important. Generally speaking, action research is not subject specific. The Logo focus enabled each of the participating teachers to increase their Logo knowledge as they investigated their practices. Action research is a process for professionals to use in reflecting on their work with the intent of changing something; taking action. Logo action researchers looked at their own practice with an eye to doing something differently in the classroom in order to improve student Logo learning.

### **Teachers as researchers**

Action research is a more qualitative than quantitative method of doing research. It is an orderly process to use in investigating a question a teacher wants to better understand. In answering an action research question, a teacher researcher will systematically collect data in order to get reliable and valid results.

The question and the data grow out of day-to-day classroom happenings. Teachers support one another by offering new ideas, looking with unbiased views, listening carefully and responding to colleagues. The Logo Action Research Collaborative developed a community of teacher-learners that worked together to investigate issues about learning Logo.

### **Phase one**

Early in the process, participating teachers became acquainted with each other, action research, and ways to support one another using processes designed by Watt and Watt. Groups brainstormed possible action research questions and individual teachers began to focus on areas of special interest. These areas included gender issues, at-risk learners, cooperative learning, conceptual readiness of third-grade Logo learners, problem-solving strategies of fourth-grade Logo users, learning tools to empower first graders, peer teaching, and connections to other curriculum areas such as math and language.

Identifying questions that were worth asking and answering was a critical aspect of our entire action research process. We didn't need to prove that something was true. It was valuable for us to discover and describe carefully what children say and do under certain conditions. It was most important to ask and try to answer a question that was important to each of us, rather than try to satisfy any predetermined pattern.

### **Phase two**

During the second phase of the year, teacher researchers developed a strategic plan, refined it, and collected data related to their question. We planned, observed, evaluated, and re-defined our plans in a recursive way. Support materials and processes such as the Question Focusing Process developed by Watt and Watt were useful at this time and throughout the year.

### **The final phase**

During the final phase of the process, participating teachers analyzed data, wrote drafts of final papers, edited one another's work, and began to share results with others.

June of 1991 did not mark the end of the Logo Action Research Collaborative. Leaders and teacher-researchers have continued to share their work in many ways, including through magazine articles, presentations at conferences such as Logosium, National Educational Computing Conference (NECC), American Education Research Association (AERA), and numerous state and local forums. Each time they share, the teachers learn more about their practice, the questions



they asked, and the importance of contributing to a culture where teachers support one another.

In reflecting on the Logo Action Research Collaborative, Dan Watt said, "One of the original intents of Logo was to develop a community of learners. The action research process has created a community of teacher-learners."

Molly Watt commented, "There is more to this than learning about action research. The teacher self-empowerment that takes place is ours forever."

### What's next?

In future articles we will explore a leader's perspective, some teacher research, and examine the relationship between Logo action research and the national restructuring efforts. ▲

**Nan Youngerman** has taught in the Madison, WI, school district since 1971. She is currently at Crestwood Elementary School, teaching science, math, and technology to first through fifth graders. This past year she was the 1994 Wisconsin Presidential Awardee for Excellence in Mathematics and Science Education sponsored by the National Science Foundation. She can be reached during the school year at: Crestwood Elementary School, 5930 Old Sauk Road, Madison, WI 53705; or anytime via e-mail at neyounge@facstaff.wisc.edu

### References

Watt, Molly Lynn & Watt, Dan Lynn (1991, April). *Classroom Action Research: A professional development opportunity for experienced teachers*. Paper presented at the American Education Research Association, Chicago, IL.

## Roamer Turtle Now Available

Cambridge, MA—Harvard Associates is pleased to announce the availability of the Roamer robot, the very latest in Logo technology. The Roamer combines robotics with Logo for even the youngest child.

Roamer is designed to be sturdy, with few moving parts and a simple and friendly round, dome-like shape. It is easy to use—with a brightly-colored touchpad featuring single keystrokes for commands—and is lightweight and robust. Roamer is battery-powered, weighs approximately four pounds, and is designed to offer many hours of Logo adventures.

"Roamer is the ideal way to introduce Logo commands in your classroom. It brings Logo to life in a friendly and tangible way," noted Bill Glass, president of Harvard Associates, the distributor of Roamer in North America. "Since Roamer has Logo already on board, it's like having an extra computer, dedicated to your Logo lessons, in your classroom. Children can touch, feel, and follow the Logo turtle as it moves about your classroom," he concluded.

Available kits make it possible to customize Roamer. There are four different shapes to change Roamer's color to red, yellow, white, or green. Insert a colored marker pen and watch Roamer draw fascinating designs.

Roamer can also play music. Pitch, duration, and tempo add an extra dimension to any Logo lesson.

A simple and clear User Guide and an Activity Book accompany Roamer to start students on their way to hours of Logo fun and learning.

Roamer is available now for \$299.95 from Harvard Associates. For more information or to order Roamer, contact Mr. André Rossi at Harvard Associates: 800/774-LOGO.

# CLIME Notes

## Council for Logo & Technology in Mathematics Education

by Ihor Charischak

---

[Editor's Note: *LX* has invited CLIME to share some of its Logo activities with us. This first article includes an overview of CLIME, notes about its 1995 meeting, plans for the future, and a short activity from Volume II of "Microworlds" (not related to the commercial product). Look for more mathematical explorations from Ihor in future issues of *LX*.]

### A brief history of CLIME

- 1986 CLIME, the Council for Logo in Mathematics Education, is founded. Its mission is to enhance the effectiveness of teaching of mathematics through the use of the Logo language and the teaching philosophy it has come to represent.
- 1987 Publication begins of *Clime Connections*, a periodic newsletter of reflections, activities, reviews, feature articles, and news.
- 1989 CLIME becomes an affiliate group of NCTM (National Council of Teachers of Mathematics), the only affiliate group with technology as a theme.  
CLIME produces "Microworlds, Vol. I," containing teacher developed Logo programs for exploring mathematics.
- 1990 CLIME produces "Microworlds, Vol. II."
- 1992 NCTM overwhelmingly approves a resolution to create a Technology and Mathematics Education Advisory Committee (although that committee has yet to be established).
- 1993 The name of the organization changes slightly to the Council for Logo & Technology in Mathematics Education. The current mission is:
1. to promote the possibility of having teachers and students fall in love with mathematics with the help of a family of powerful software environments,

which includes the various dialects of Logo.

2. to share with the larger mathematics community our vision of Logo and how technology can make a significant difference in their lives.
3. to be a catalyst for the role of technology in achieving the vision of the Standards and encourage NCTM to continually demonstrate that the use of technology should be at the forefront of the reform movement.

### CLIME 1995

Last April, CLIME held its annual meeting during the Boston NCTM meeting, with more than 80 people in attendance. Despite the fact that Seymour Papert was unable to participate in the program, the session went well. The focus was on effective uses of technology in teaching math. The Logo feature was a demonstration by Doug Clements and Julie Sarama of applications using the program *Turtle Math*. Other Logo-like software applications that were demonstrated included *Tabletop* and *Geometry Inventor*. There were also two video presentations of teachers using technology.

### Looking ahead to 1996

In April 1996, CLIME will celebrate its 10th anniversary and is planning a gala event in San Diego at the annual NCTM meeting. We will be taking a trip down memory lane reliving important milestones in the evolution of Logo and Logo-Like. We will also be featuring examples of exemplary uses of technology in the teaching of math. If you are planning to be in San Diego, have an excellent technology classroom idea to share, and are interested in participating in the program, please contact me. (See below.)





Since becoming an affiliate group of NCTM, CLIME has been interested in promoting effective uses of technology within the NCTM organization. In 1992 I participated in an NCTM task force that updated NCTM's position statements on technology. In the coming year CLIME hopes to accomplish the following three NCTM-related goals:

1. There is a need for the CLIME meeting to be integrated into the general meeting program rather than to be scheduled at the end of the day. We will be supporting the Women in Mathematics group in trying to make this happen.
2. We hope to influence NCTM to organize a technology panel presentation that would include Seymour Papert. It amazes me that one of the premier proponents of the use

technology in mathematics education has never been invited to participate in an NCTM event!

3. We hope to create at a future NCTM meeting a technology "poster" session, which would be an all-day forum for teachers to present effective strategies for teaching and learning with technology.

I need your help in these endeavors. If you are interested in helping, please contact me at: Stevens Institute of Technology – CIESE, Castle Point, Hoboken, NJ 07030. Telephone: 201/216-5076; e-mail: [icharisc@stevens-tech.edu](mailto:icharisc@stevens-tech.edu)

The annual CLIME membership is \$10.00 (USA), \$15.00 (elsewhere) and includes a subscription to *Clime Connections*. To join, please contact me at the above address. ▲

## The Power of Two

by Ihor Charischak

Unisys, a merger of Sperry and Burroughs, used the expression "The Power of 2" in an advertisement to indicate that the merged entity would be greater than the sum of the two former companies. This reminded me of a math trick I have used to help students understand the power of "doubling."

I challenge my class to imagine folding a piece of paper in half indefinitely. I start by folding a piece of paper in half and then in half again. By the fifth or sixth fold it is no longer physically possible to fold the paper in half. I ask the class to measure how thick the paper is at this point and we start a chart:

fold	thickness
5	1/4"
6	1/2"

Now what would happen if we could continue to fold? The chart grows with our theoretical folding.

fold	thickness
5	1/4"
6	1/2"
7	1"
8	2"
9	4"
10	8"
11	16"

Everyone now understands that each fold doubles the thickness of the stack. Next I ask how many folds it would take to build a tower that would reach the moon. Guesses usually range from thousands to billions. But to the surprise of most students, it takes only 41 folds to build the tower. It is clear that they do not have a sense of

the power of doubling. Now we switch to a Logo program to help us with the calculations.

## The program

This program is written using Terrapin's *Logo PLUS for the Macintosh*, although the commands used are found in most versions of Logo. You may need to use **ifelse** instead of **if** in your version of Logo.



39 folds produces

4288095348 inches  
357341279.0272 feet  
119113759.67573 yards  
67678.27254393 miles



Earth

The tower is now visible.  
←

The distance from the earth to the moon is approximately 250,000 miles.

```
to setup
  cleartext
  print [Power of Two]
  print []
  print [By CLIME Staff]
  repeat 2 [print []]
  cleargraphics
  hideturtle
  moon
  start.stack
  print [Type FOLDS followed by a number.]
end
```

```
to start.stack
  setheading 0
  penup setpos [-2 -76.5] pendown
  setheading 270
  forward 10 back 20 forward 10
  setheading 0
end
```

```
to moon
  penup setpos [-20 65] pendown
  setheading 0
  repeat 36 [forward 3 right 10]
end
```

```
to folds :number
  if :number > 50 [print [Try starting
    with a smaller number.] stop]
  fix powers 1 :number 0.0078
  print []
  if :number < 33 [print [No visible evi-
    dence of tower.]] [print [The tower is
    now visible.]]
  print []
  if :number > 41 [print [Your tower made
    it to the moon!!!] stop]
  print [Press any key to see another
    fold.]
  make "key rc
  folds :number + 1
end
```

```
to fix :list
  start.stack
  cleartext
  forward ((last :list) * 2) / (12 * 5280)
    / 4000
  (print first :list [folds produces])
  print []
  (print last :list [inches])
  (print last :list / 12 [feet])
  if :number > 3 [(print (last :list) / 36
    [yards])]
  if :number > 12 [(print ((last :list) /
    12) / 5280 [miles])]
end
```

```
to powers :start :finish :num
  if :finish = :start [output list :start
    2 * :num]
  output powers :start + 1 :finish :num *
    2
end
```

To start the program, type the following:

setup



In addition to founding CLIME in 1987 and supporting it ever since, **Ihor Charischak** is program manager for the Center for Improved Engineering and Science Education (CIESE) at Stevens Institute of Technology. His latest project is managing a three-year NSF-funded mentorship project, which involves 40 math teachers (grades 7-10) from 16 school districts in New Jersey who have been learning to use technology in their classrooms and to share their knowledge with their colleagues. He can be reached via e-mail at [icharisc@stevens-tech.edu](mailto:icharisc@stevens-tech.edu).



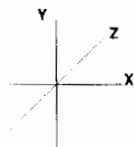
# Turtle CAD: Computer-Aided Design in Logo

by Jim Muller, The Logo Forum on CompuServe

Logo has always had its “naysayers.” There have been research studies that supposedly prove there is no transference from Logo to other subjects. They tend to add credence to the old adage that you can bring a horse to water but you cannot make it drink—you can teach children, but you cannot “learn” them.

I have always believed that if you create an environment in which that horse gets very thirsty, then it will drink. By the same token, if you create a rich, multidimensional learning environment that sparks children’s imaginations, they will learn in spite of themselves.

Such was the case when working with eight- to ten-year-olds as described in the Beginner’s Column in this issue, “From Two to Three Dimensions.” When my son and his friends saw the work that those third-grade students had done creating patterns on the screen and then folding the printed output into three dimensional objects, they wondered if it would be possible to work in three dimensions on the Logo screen. They were thoroughly familiar with the two dimensions of the x - y coordinate system. Could this be expanded to serve three dimensions: x, y, and z?



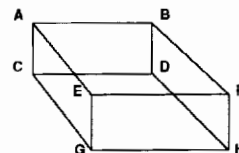
Yes, it can. In addition, the resulting program offers a good look at property lists, an often confusing feature of Logo.

## 3-D programming

In the program at the end of this article, the basic unit is the coordinate point as defined by the **point** procedure. Points have letter names and x, y, and z coordinates to position them in three-dimensional space. Once you have defined

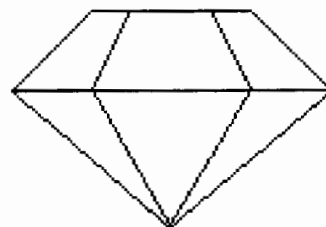
all the required points by name and position, you can construct shapes.

The **figure** procedure takes the shape name and a list of two-point lists; for example, `[[A B] [A C] [A E] [B D] [B F] [C D] ...]`. The two-point lists represent the line segments of the shape with each letter representing an endpoint, as illustrated below.



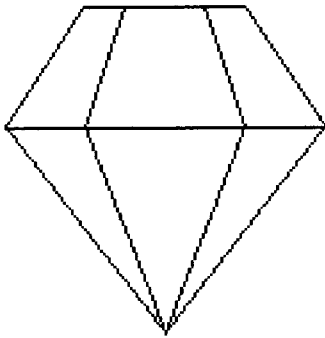
The program allows you to create as many shapes as you want, but only one can be manipulated at a time.

Once you have defined your shape, you can expand it or contract it, rotate it, magnify it, shrink it, and then restore it to its original shape. Here, for example, is the original **diamond** shape:



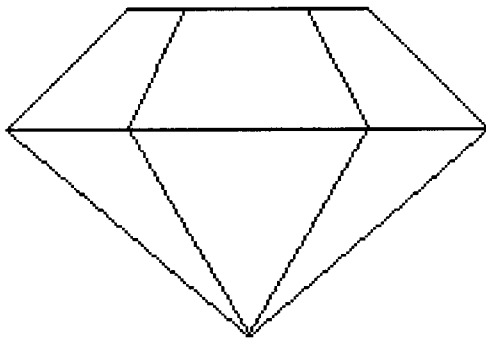
After the shape has been generated, it is assigned a new name, by which you then manipulate it. **Diamond** now becomes **Gem**.

Use **expand** to expand a shape. Tell the procedure which shape to expand, which axis the expansion will operate on, and how much to expand it.



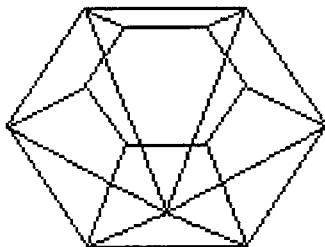
expand "gem "y 1.5

**Magnify** is very similar to expand. However, you don't specify an axis because the figure is magnified in all directions.



magnify "gem 1.5

**Rotate** operates on a plane: xy, xz, or yz. Specify the shape, the plane, and the degrees of rotation you want to see.



rotate "gem "yz 60

As you move your shape through space, the turtle remembers the position of your shape and moves it from its last position. When you want to

start over with a new shape, or start from your shape's original position, use:

restore "gem

To get you started, there are two examples provided in the procedure below: a diamond and a box-like car. Type **diamond** or **car** to see a front view of the figure. (Remember to use **gem** and the car's new name, **auto**, when you manipulate them.)

Try rotating the figures using commands such as this sequence:

```
car
rotate "auto "xy 45
rotate "auto "yz 30
```

Now you're ready to start off on your own.

For a copy of this 3-D program, contact me at the e-mail address listed at the end of this article. This and many other Logo programs are available on the CompuServe Logo Forum, GO LOGOFORUM.

### The program

The following program was written using *MSWLogo*. However, it adapts easily to almost any version of Logo with **sin** and **cos** primitives.

If your version of Logo does not have property list commands, define the **gprop** and **pprop** procedures listed at the end of the article. For some versions of Logo, you will need to change **memberp** to **member?**. If you are using *PC Logo*, change **setpos** to **setxy**. For other versions that have **setxy** but not **setpos**, define the following procedure:

```
to setpos :list
  setxy first :list last :list
end
```

Following is the complete program.

```

to diamond
point "a [60 0 60]
point "b [0 51.961 51.961]
point "c [30 51.961 103.92]
point "d [90 51.961 103.92]
point "e [120 51.961 51.961]
point "f [90 51.961 0]
point "g [30 51.961 0]
point "h [45 81.961 25.98]
point "i [30 81.961 51.961]
point "j [45 81.961 77.941]
point "k [75 81.961 77.941]
point "l [90 81.961 51.961]
point "m [75 81.961 25.98]
figure "gem [[a b] [a c] [a d] [a e] [a
f] [a g] [b c] [b i] [c j] [c d] [d k]
[d e] [e l] [e f] [f m] [f g] [g h] [g
b] [i j] [j k] [k l] [l m] [m h] [h
i]]
end

```

```

to car
point "a [0 0 0]
point "b [0 20 0]
point "c [40 20 0]
point "d [40 0 0]
point "e [0 20 40]
point "f [0 40 40]
point "g [40 40 40]
point "h [40 20 40]
point "i [0 20 80]
point "j [0 40 80]
point "k [40 40 80]
point "l [40 20 80]
point "m [0 0 120]
point "n [0 20 120]
point "o [40 20 120]
point "p [40 0 120]
point "q [0 10 0]
point "r [10 10 0]
point "s [10 20 0]
point "t [40 10 0]
point "u [30 10 0]
point "v [30 20 0]
figure "auto [[a b] [a d] [a m] [b c] [s
r] [r q] [b e] [c d] [t u] [u v] [c h]
[d p] [p o] [p m] [o l] [o n] [n m] [n
i] [i j] [i l] [j f] [j k] [k l] [k g]
[g h] [g f] [f e] [e h]]
end

```

```

to point :pointname :coords
make :pointname :coords
pprop :pointname "point "true
pprop :pointname "orig :coords
end

to figure :shapename :lp
if (gprop :shapename "point) = "true
  [(print :shapename [is already a point
name.]) stop ]
make :shapename :lp
pprop :shapename "figure "true
make "sx (word :shapename "pts)
make :sx [] make "n9 1
repeat count :lp [tsf :n9 ts1 :n9 make
  "n9 :n9 + 1]
make "matrix [1 0 0 0 1 0 0 0 1]
draw.it :shapename
(print :shapename [is now a shape.])
end

```

```

to draw.it :figure
make "s9 thing (word :figure "pts)
repeat count :s9 [make "p9 first :s9
  make :p9 (list (item 1 :matrix) *
    (item 1 thing :p9) + (item 2 :matrix)
    * (item 2 thing :p9) + (item 3 :ma-
    trix) * (item 3 thing :p9) (item 4
    :matrix) * (item 1 thing :p9) + (item
    5 :matrix) * (item 2 thing :p9) +
    (item 6 :matrix) * (item 3 thing :p9)
    (item 7 :matrix) * (item 1 thing :p9)
    + (item 8 :matrix) * (item 2 thing
    :p9) + (item 9 :matrix) * (item 3
    thing :p9)) make "s9 butfirst :s9]
clearscreen
showturtle
make "s9 thing :figure
repeat count :s9 [penup setpos butlast
  thing (first first :s9) pendown setpos
  butlast thing (last first :s9) make
  "s9 butfirst :s9]
end

```

```

to restore :figure
if not (gprop :figure "figure) = "true
  [(print :figure [is not a shape.])
  stop]
make "n9 thing (word :figure "pts)
repeat count :n9 [make first :n9 gprop
  (first :n9) "orig make "n9 butfirst
  :n9]
make "matrix [1 0 0 0 1 0 0 0 1]
draw.it :figure
end

```



## Property Lists

Property lists allow you to associate a value with a name, which can be useful in organizing data. If your version of Logo does not include property list primitives, you can write them as procedures. This is an adaptation of a procedure in Hal Abelson's book, *Logo for the Apple II*. Byte/McGraw Hill; Peterborough, NH, 1982.

```
to pprop :name :property :value
make (word :name char 32 :property)
: value
end
```

The **pprop** procedure creates a variable whose name is a combination of the first two inputs, separated by a space (**char 32**). The value of this variable is the third input.

Let's use some familiar words to explore property lists.

```
pprop "Texas "Capital "Austin
pprop "Texas "Abbreviation "TX
pprop "Texas "Cities [Houston Dallas
[San Antonio] [El Paso]]
pprop "Texas "Region [south central]
pprop "Texas "Historic.site "Alamo
```

These instructions say: Put the **Property**, **Capital**, which has the Value of **Austin**, with the Name, **Texas**. Put the Property, **Abbreviation**, which has the Value of **TX** with the Name, **Texas**, and so on. In a sense, you can create a Logo database using property lists.

Once you have defined the properties, you can recall them using the following procedure:

```
to gprop :name :property
output thing (word :name char 32 :prop-
erty)
end
```

This procedure outputs the "thing" (the value) defined in the **pprop** procedure. For example, it might look like this:

```
gprop "Texas "Capital
result: Austin
```

Note that some versions of Logo use the primitive names **getprop** and **putprop**.

```
to rotate :figure :axis :amt
if not memberp :axis [XY XZ YZ] [print
[The axis must be XY, XZ, or YZ.]
stop]
if not (gprop :figure "figure) = "true
[(print :figure [is not a shape.])
stop]
if :axis = "XY [make "matrix (list (cos
:amt) 0 - (sin :amt) 0 (sin :amt) (cos
:amt) 0 0 0 1)]
if :axis = "XZ [make "matrix (list (cos
:amt) 0 0 - (sin :amt) 0 1 0 (sin
:amt) 0 (cos :amt) 0)]
if :axis = "YZ [make "matrix (list 1 0 0
0 (cos :amt) 0 - (sin :amt) 0 (sin
:amt) (cos :amt))]
draw.it :figure
end
```

```
to magnify :figure :amt
if not (gprop :figure "figure) = "true
[(print :figure [is not a shape.])
stop]
make "matrix (list :amt 0 0 0 :amt 0 0 0
:amt)
draw.it :figure
end
```

```
to expand :figure :axis :amt
if not memberp :axis [X Y Z] [print [The
axis must be X, Y, or Z.] stop]
if not (gprop :figure "figure) = "true
[(print :figure [is not a shape.])
stop]
if :axis = "X [make "matrix (list :amt 0
0 0 1 0 0 0 1)]
if :axis = "Y [make "matrix (list 1 0 0
0 :amt 0 0 0 1)]
if :axis = "Z [make "matrix (list 1 0 0
0 1 0 0 0 :amt)]
draw.it :figure
end
```

```
to tsl :n9
if not memberp last (item :n9 :lp) thing
:sx [make :sx fput last (item :n9 :lp)
thing :sx]
end
```

```
to tsf :n9
if not memberp first (item :n9 :lp)
thing :sx [make :sx fput first (item
:n9 :lp) thing :sx]
end
```

▲

**Jim Muller** organized the first Logo users group, the Young Peoples' Logo Association in 1981. In 1985, the YPLA merged with CompuServe where it became The Logo Forum. Today, Muller is a computer training and marketing consultant in the Dallas/Fort Worth metroplex. For a complete biography, refer to page 8. You can reach him by e-mail at 76703.3005@compuserve.com or on CompuServe at 76703,3005.

## Logosium '95

The second annual Logosium was held in Baltimore, MD, on June 16 in conjunction with the National Educational Computing Conference. The day-long event was cosponsored by ISTE's SIG-Logo and the Logo Foundation.

More than 50 participants discussed the following topics, listed with their facilitators, during the day's four sessions. In addition, a computer lab was set up with several versions of Logo available for use.

- *Logo on the Internet* with Michael Tempel
- *LEGO DACTA® Control Lab™* with Tom Lough
- *Textile Design (for the Last Time!)* with Orlando Mihich
- *Logo, Math & Music* with Hope Chafian and Eleanore Bednarsh
- *Meet the Editors of LX and Logo Update* with Dorothy Fitch and Michael Tempel
- *Children & Publishing, Multimedia Style* with Susan van Gelder
- *Children's Logo Conferences* with Mel Levin and Eleanora Badilla
- *Geometry Tool Kits with MicroWorlds* with Gary Stager

- *NCTM Standards, Where's the Reform?* with Ihor Charischak
- *MicroWorlds' Graphics Secrets* with Jerry Crisci
- *Programmable Brick* with Mitchel Resnick
- *Talk to the Developers* with Sharnee Chait and Dorothy Fitch
- *Logo Research* with Doug Clements and Julie Meredith Samara
- *Keeping 'Em Down on the Logo After They've Seen MicroWorlds* with Marian Rosen
- *Logo Down Under* with Steve Costa
- *StarLogo 1.0* with Mitchel Resnick

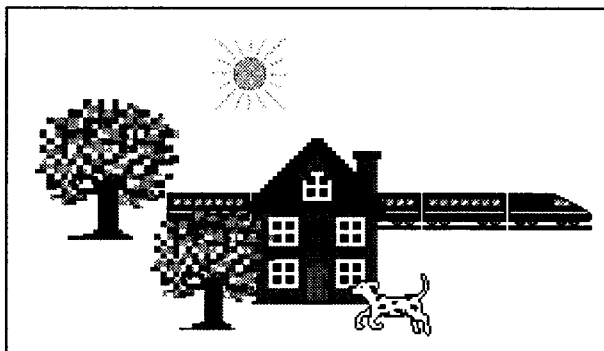
Plans are already under way for next year's Logosium, which will take place in conjunction with NECC '96 in Minneapolis, MN. If you have ideas for sessions, please contact either Michael Tempel at the Logo Foundation or Marian Rosen:

michaelt@media.mit.edu	212/765-4918
mbrosen@oui.com	314/721-0408

# Control Simulations (Part 1): Lamp and Temperature Sensor

by Glen L. Bull, Gina L. Bull, and Todd Kent

*MicroWorlds*, from LCSi, includes all of the features of its predecessor, *LogoWriter*, as well as the ability to create pages akin to cards in *HyperCard* stacks and the ability to stamp shapes in a manner similar to that found in *KidPix*. First-time users often begin by using the shapes and drawing tools to create a landscape. The Logo turtle shapes can be used to create scenes that might include an animated train running in the background and perhaps a dog walking along a path. Hypertext and clickable objects are often used to branch to another page in a project.



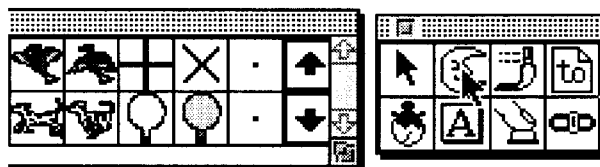
While clickable hypertext and hypermedia objects are potentially powerful educational tools, hypertext and hypermedia capabilities alone do not exploit the full capabilities of *MicroWorlds*. The term “microworlds” suggests the potential for construction of educational simulations. To illustrate, we would like to outline one approach to simulating thermostatic control and feedback using *MicroWorlds*.

## Constructing a simulated lamp

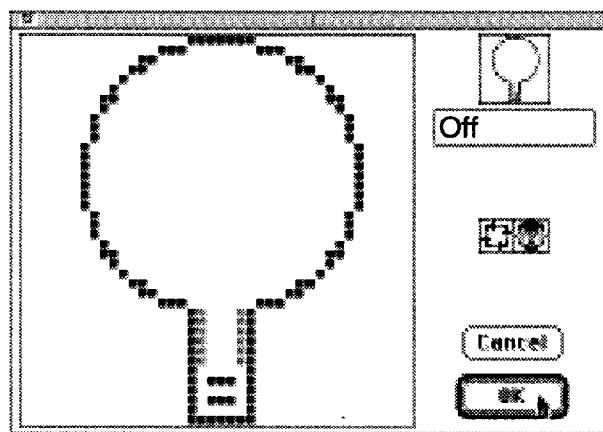
In this first of a two-part series, we will construct a light bulb that can be turned on and off, and use it to heat a thermometer. In the next issue of *Logo Exchange*, a simulated fan will be

developed to cool the temperature sensor. Finally, a thermostatic control that models those used in home heating systems will be developed.

To construct a light bulb, click the moon icon in the tools palette to access the shapes center. A number of premade shapes, such as the cardinal and Dalmatian shapes, are provided. It will be necessary to create two new shapes for this project: an icon of a light bulb that has been turned off, and an identical one that has been turned on.



To begin, double-click an empty square in the shapes center. This will place you in a shape-edit mode in which new shapes can be constructed. In this instance, we have combined a circle with a rectangle on the bottom to form a light bulb. We have assigned the name “Off” to this light bulb, because it represents a light that has been turned off.



When you are finished, click the OK button to exit the shape-edit mode. Then select the Copy option from the Edit menu at the top of the screen to copy the shape to the clipboard.

Next, click a second empty square in the shape center and select Paste from the Edit menu to paste the copy of the light bulb into the second square.

Double-click the second light-bulb shape to enter the shape-edit mode again. Click on the color yellow in the paint palette and then select the paint bucket from the paint tools. Click the light bulb in the center of the shape to fill it with yellow (representing a light bulb that has been turned on). Enter the name "On" as the name of the second shape. Then click OK to exit the shape-edit mode.

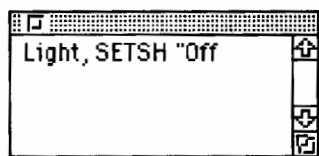
After the two shapes (representing one light bulb that has been turned off and a second one that has been turned on) have been created in the shapes center, select the pointer tool in the tools palette. Hold down the Shift key and double-click the turtle. This will produce a dialog box in which you can name the turtle. Change the default name of "T1" to the name "Light" when the dialog box appears. Then click OK to exit the dialog box after naming the turtle.



To change the shape of the turtle named Light into a light bulb, enter the command

Light, Setsh "Off

in the command center, and press the Return key.



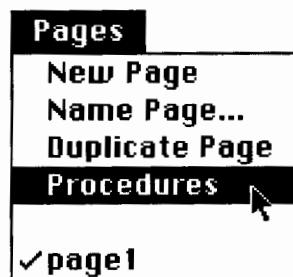
This should cause the turtle to shift to the shape of a light bulb. [Troubleshooting tip: it is

important to place a quotation mark in front of the shape name ("Off) but not after it. Because quotation marks usually come in pairs, before and after, in English (though not in Logo) this is a common error.] If the turtle successfully shifts to the shape of a light bulb, turn on the light bulb by using the second shape, entering the following command in the command center:

Light, Setsh "On

This command should cause the shape of the turtle to shift to the shape of the light bulb filled with yellow.

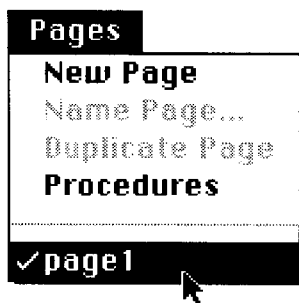
If the foregoing is successful, a Logo procedure can be constructed to toggle the shape on and off. Select the Procedures page under the Pages menu at the top of the screen to enter the Logo editor.



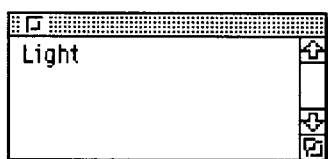
Enter the following procedure in the Procedures page:

```
To Light
  Talkto "Light
  If Shape = "Off [Setsh "On Stop
  If Shape = "On [Setsh "Off Stop]
End
```

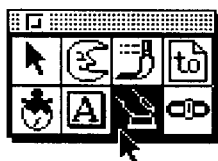
This procedure checks to see if the shape of the turtle named Light is set to "Off. If the current shape is "Off, the procedure changes the shape to "On. By reversing the current shape, the procedure toggles the light from off to on, or vice versa. After entering the procedure in the Procedures page, choose page1 from the Pages menu to return to the original page on which you were working:



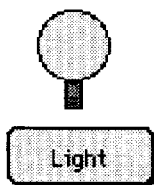
After completing the procedure, enter the word "Light" in the command center and press the Return key. Each time this is done, the state of the light should reverse, from on to off, or vice versa.



If the Light procedure works properly, create a button to turn the light on and off. Begin by selecting the button tool in the tools palette.



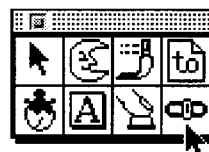
After selecting the button tool, click anywhere on the page. A dialog box for the button should appear. Enter the procedure name Light in the section of the button dialog box titled Instruction. Then click OK to exit the dialog box.



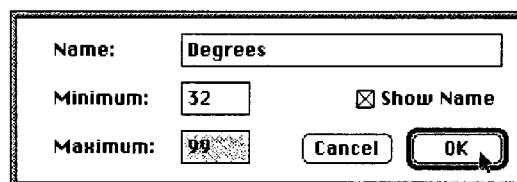
Drag the button underneath light bulb. Each time the button is clicked, the state of the light bulb should change, from on to off, or vice versa.

## Constructing a simulated thermometer

While the simulated light bulb is turned on, it should generate heat. A *MicroWorlds* thermometer can be created to measure the increased temperature. To accomplish this, first select the slider tool in the tools palette.



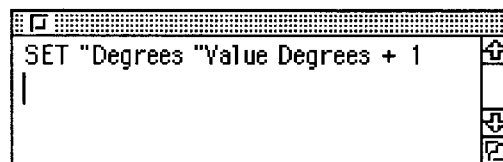
After selecting the slider tool, click anywhere in the page. A dialog box should appear. Enter the word "Degrees" in the name box and enter the minimum and maximum temperatures that you will want to measure in the corresponding boxes. (We have chosen to enter the values of 32 degrees and 99 degrees in the sample dialog box below.) After entering this information, click the OK button.



The slide bar created in this way will provide a means of monitoring the simulated temperature.



To change the temperature measured by the Degrees slider bar, enter the following command shown in the illustration below, and press the Return key.



This command should increase the temperature registered by the Degrees slider bar by one de-

gree. (The command literally says, in Logo, "Set the value of the slider bar named Degrees to its current value plus one more.") [Troubleshooting tip: Be sure to include a space before and after the "plus" sign, exactly as shown in the example.]

If this command successfully changes the value displayed on the slider bar by one degree, a Thermometer procedure can be created that will monitor the simulated increase in temperature that will occur whenever the light bulb is turned on.

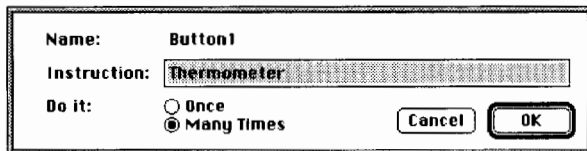
Return to the Procedures page and enter the following three procedures. The Thermometer procedure increases the simulated degrees if the light is on. The Light? procedure checks the shape of the turtle to determine whether the light is on. The IncreaseDegrees procedure increases the value of the Degrees slider when the light is on.

```
To Thermometer
  If Light? [IncreaseDegrees]
End

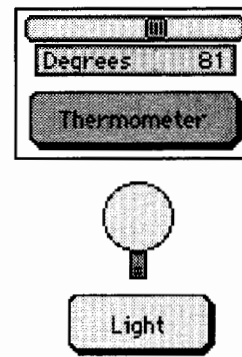
To IncreaseDegrees
  If Degrees > 98 [Stop]
  Set "Degrees "Value Degrees + 1
End

To Light?
  Light, Output Shape = "On
End
```

After these three additional procedures are added to the Procedures page, return to page 1 (see graphic on page 30). Select the button tool from the tools palette and click anywhere on the page. A button dialog box should appear. Enter the procedure name "Thermometer" in the instruction box and select the Many Times option. (It is crucial to select Many Times or the procedure will not operate properly.) Once this is done, click the OK button to exit the dialog box.



Place the Thermometer button below the Degrees slider bar and click it once to activate it.



As long as the Thermometer button is activated, the Degrees slider bar should register a continuing increase in simulated temperature whenever the light is turned on. If the slider bar reaches the maximum temperature, you can turn off the light and drag the Degree slider bar back to the left to start over again.

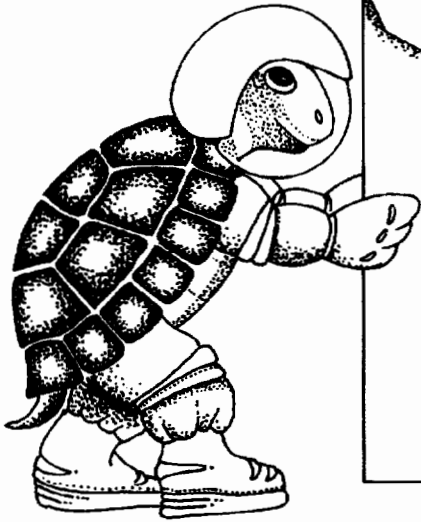
## Summary

The "microworld" begun in this column illustrates some of the possibilities of a *MicroWorlds* simulation. In the next issue, we will develop two additional devices: a fan to cool the temperature sensor and a thermostatic control.

A graphical microcomputer interface with windows supports many more objects such as buttons, sliders, and other control devices that can be used to good effect in simulations. In a virtual world, the number of such devices and the uses to which they are put is limited only by the memory of the computer and the imagination of the user. ▲

**Glen Bull** is an associate professor in the Instructional Technology program of the Curry School of Education at the University of Virginia. **Gina Bull** is a computer systems engineer in the Information Technology and Communication organization at the University of Virginia. **Todd Kent** is a graduate instructor in the Curry School specializing in instructional uses of technology. They can be reached via e-mail at:

GBull@Virginia.edu  
Gina@Virginia.edu  
TKent@Virginia.edu



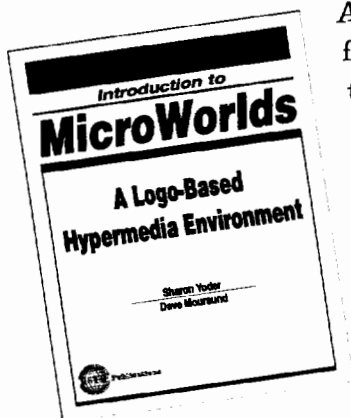
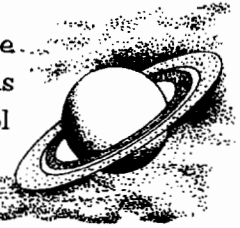
## Push the envelope with MicroWorlds



Launch your students toward stimulating new classroom challenges and adventures. They can soar to a galaxy of new skills using MicroWorlds.

MicroWorlds is an exciting application that offers in a single program many of the features available in HyperCard, Kid Pix, and LogoWriter.

You're the pilot. Get ready now to grab the controls, blast off, and explore these exciting new worlds with your class! To help you prepare your crew for this fantastic voyage, Sharon Yoder and Dave Moursund back at mission control have developed a 222-page flight manual titled *Introduction to MicroWorlds—A Logo-Based Hypermedia Environment*.



As a computer application, MicroWorlds contains a wide range of features that make it easy and fun to work with color graphics, sound, text, and animation. As a programming environment, MicroWorlds includes a powerful and modern version of the Logo programming language.

It's time to broaden your universe. The countdown is underway. Have a nice trip!



**International Society for Technology in Education**  
Customer Service Office  
480 Charnelton Street, Eugene, OR 97403-2626 USA  
Phone: 800/336-5191 Fax: 503/302-3778  
Internet: [iste@oregon.uoregon.edu](mailto:iste@oregon.uoregon.edu)

HYPERCARD® IS A REGISTERED TRADEMARK OF CLARIS CORPORATION, SANTA CLARA, CA, U.S.A. KID PIX® IS A REGISTERED TRADEMARK OF BRØDERBUND SOFTWARE, NOVATO, CA, U.S.A. LOGO®, LOGOWRITER® AND MICROWORLDS® ARE REGISTERED TRADEMARKS OF LOGO COMPUTER SYSTEMS, INC., HIGHGATE SPRINGS, VT, U.S.A.





# Logo: Search and Research

## Delayed Effects of Logo

by Douglas H. Clements and Julie Sarama

---

Many studies that we've discussed measured whether Logo affects students' achievement, thinking, and attitudes. Not many have looked at *delayed* effects. Might Logo have a large long-term effect?

In this column we'll discuss several research results that indicate that Logo does have a delayed benefit. In the next column we'll move to several even more surprising studies.

### Why expect a delayed effect?

The Logo computer language was developed to serve as a conceptual framework for teaching problem-solving skills and subject-matter content. Many teachers and researchers took this to mean that Logo would increase students' mathematics achievement. Mere exposure to Logo, however, may or may not increase test scores; the research is mixed (Clements & Meredith, 1993).

But using Logo as a conceptual framework is *not* the same as "providing practice with," or directly teaching, mathematical ideas. Rather, Logo is a tool for building new mental foundations—frameworks for all future learning and problem solving. As such, its effects may not be immediate and direct, but delayed and diffusive.

### Is there evidence of a delayed effect?

Some.... We saw Enrique Ortiz and Diane Miller present a research paper at the National Council of Teachers of Mathematics (1991). They compared a Logo and a textbook approach to teaching the idea of variable. A delayed retention test indicated that the Logo group had a firmer idea of variable.

### A longitudinal study

I assessed the long-range effects of Logo programming with children who had participated in either Logo or Computer Assisted Instruction

(CAI) drill sessions. Following Logo experience, the Logo first graders had made significant gains in measures of creativity and reflectivity. They also significantly outperformed the CAI group on assessments of cognitive monitoring, or "knowing whether you understand" (Clements & Gullo, 1984). I returned two years later to examine their standardized tests and to interview them (asking them about their thinking on those tests) in their third-grade year (Clements, 1987).

### Higher-order thinking

Compared to the CAI children, the Logo children solved more problems that demanded higher-order thinking skills. Logo also had a delayed effect on certain areas of achievement, such as reading vocabulary and comprehension. This may have resulted from the long-term benefits on higher-order thinking.

### Language

There were large effects on the language mechanics. Early extensive experience with a computer language that demands exacting attention to detail, including punctuation and other syntactical forms, may have encouraged the Logo children to build strategies for processing information more exhaustively. Also, detection and correction of syntactic errors in the Logo work may have affected future processing of similar situations.

### Mathematics

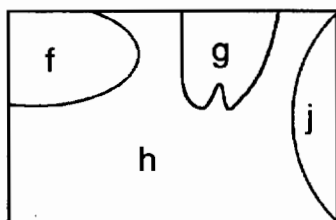
There was a moderate effect on mathematics computation. This may have resulted from direct practice, as suggested by several of the children themselves. If so, however, why didn't the CAI treatment have a similar effect? It may be that computation in Logo, involving multidigit operations in a problem-solving setting, stretched children's capabilities and provided a novel model

for the operations. In contrast, the CAI children practiced counting and simple addition specifically “geared to their level.”

### Why these effects?

The interviews revealed that Logo may have provided children with ideas that helped them choose the “correct” answer for some items on a standardized mathematics achievement test, but “misled” them on other (especially geometric) items.

The first of two geometric items asked children to identify which letter within a rectangular frame was “in a circle.”



On the test, no child in the Logo group answered this item correctly (i.e., “none of the above”); however, 28% of the CAI group children selected that answer. In the interview, I asked them to answer the same item and explain their thinking. Four of the CAI children chose “none of the above.” Justifying that answer, a boy said, “There’s no whole circle. That’s an oval; that’s only part of a circle.” Three CAI children selected “j.” One stated, “Half of the circle is there (j). They just didn’t put the rest in.” The others had similar justifications. To each child who chose a letter, I said that the “people who made the test say that the right answer is ‘none of the above.’ What do you think?” All three were willing to accept that answer.

Of the five Logo children who answered “j,” three agreed that the “none of the above” option would be correct, if, as one boy stated, “you didn’t know the rest of the circle would be here” (tracing with his finger). One steadfastly refused to agree with the test constructors, stating that “It curves like a circle. Like a TV, the rest just didn’t fit—it would be here.”

Two of the Logo children selected “f.” A boy’s justification was that “‘j’ is less of a complete circle. You would need to go around more.” Two selected “none of the above” during the interview. One stated “That’s (j) only half of a circle;” the other, “Because, this is too out (indicating the width of ‘f’), this one is too squiggly, and this one is not a whole circle. That one is nothing—just the background.”

Both in the test and the interview, the children who had constructed and used Logo procedures that generated circles and circle sections selected the distractors more often. It may be that the Logo experience created a conception of “circle” that accepted arcs as bona fide circles, especially as many of their Logo circles split the shape on the screen. Logo children’s ideas about circles were more process oriented (“curves like a circle;” “go around more”). The CAI children had a static conception of a complete circle, which may have helped them respond “correctly” to the test item.

### Where are the angles?

Another geometric test item on which the CAI children performed slightly better (86%) than the Logo children (67%) posed the question, “How many angles does a triangle have?” Both on the test and in the interview, six of seven CAI children answered “three.” Their explanations were similar: “I just knew.” However, five of them, when asked to “show me the angles,” indicated the sides. When told, “Those are the sides,” three pointed to the intersection of two sides and asked “Here?”, and the other two admitted that they did not know what an angle was. The sixth child identified the angles by pointing immediately. When asked, “What are angles?” she queried in return, “Points?”

The seventh child demonstrated a slightly different conception. She responded, “Two. No, one.”

Examiner: “Where would they be?” (drawing a triangle)

“This is the same as the others.” (pointing to the side nearest to her)

E: “So how many would there be?”

“Three.”

E: "Is that what an angle would be, this (pointing to the sides), this, and this?"  
"If they're not straight, like."

E: "So if we drew it like this..." (notices that he drew his first triangle with a horizontal base from his perspective; draws another triangle with the horizontal base from the child's perspective) "it would be..."

"This one and this one."

E: "How about this one?" (pointing to the base).

"No."

Thus, her idea of angle was of a "slanted" line segment, "tilted" from her egocentric frame of reference.

Of the Logo children, three similarly answered "three," yet indicated the sides when asked to "Show me the angles." When told those were sides, they identified the intersections as the angles. Two children answered "two" and identified the "slanted" sides that were not parallel or perpendicular to the bottom edge of the paper. When asked to "draw an angle," they both drew a single, slanted line segment.

The sixth child originally said "Easy. Three sides."

E: "Not sides. Angles."

"Oh. They're little parts."

E: "Little parts? Show me."

"Here." (He draws two small line segments at an intersection.) "The 'V' part."

E: "How many of those?"

"Six" (points to each line in each "V" angle as he draws it).

Three Logo children asked a question immediately. One, S.C., asked, "What do you mean...corners?"

E: "What do you think it means?"

"This" (pointing to a vertex angle).

E: "Then how many would a triangle have?"

"Three."

E: "What else could it mean?"

"The sides."

E: "How many would there be?"

"Three."

Two girls asked, "What are angles?" When asked, "What do you think angles are?," the first said, "I was thinking of corners"; the second, "It could be where two parts come together." In response to "How many would there be in a triangle, then?," they both said, "Three."

Certainly, these children did not have a firm idea of "angle." Most interpreted the term as a synonym for "side." Other half-formed ideas included notions of "slanted lines," "points" or "where the two parts meet," and "two short intersecting lines" (the "V" angle). Just as important, there is evidence that work with Logo influenced children's construction of ideas about angles, but possibly to the detriment of their test performance. On the test, two children answered "four." One, S.C., answered "three" to the original question in the interview, but stated that the turtle would have to make four angles. (He included the initial rotation.) The other correspondences between test and interview performances were not as clear. The other boy who had responded "four" on the test answered "two" ("slanted lines") during the interview. The boy who had answered "two" on the test answered "three," then "six" ("Vs") during the interview. I could not tell if he previously had considered "slanted lines," the minimum of two turns necessary to complete a triangle (without returning the turtle to its original orientation), or any other possibility.

Proportionally more CAI than Logo children stated the correct answer; however, five of the seven conceived of angles as "sides," one as "slanted lines," and one as "points." In contrast, three of the nine Logo children initially interpreted angles as sides, two as "slanted lines," one as "Vs", two as "corners," and one as "where two parts come together." This indicates more awareness, albeit imperfect awareness, of angles for the Logo children. There was no evidence, however, that the Logo children's ideas about angle included a dynamic, or process, component. They said the turn commands made angles, but did not

initially connect the idea of angle with ideas about turn or measure. The child who said that “the rights” make angles was asked, “What are angles?” He replied, “I don’t know. I guess they’re like the turns...the rights.” S.C., of course came upon the connection in the context of recalling turtle commands. Although this realization appeared satisfying, clearly his previous use of the term “angle” within the Logo context was limited to that context. Even given the realization, the notions of “turn” and “angles in a triangle” remained undifferentiated.

### Children’s views of Logo’s benefits

Finally, I asked the Logo children, “Did working with the turtle ever help you do math?” Recognizing their highly subjective nature, the children’s responses were nonetheless stimulating and suggestive. One boy claimed that **repeat** statements helped him with “multiplying and dividing...like the rule to turn all the way around is 360, and when you didn’t know what the number to turn was, you just divided by...ummm...360 divided by the number of sides” (i.e., the sum of the external angles of a regular polygon is 360 degrees). Another boy’s response included mental arithmetic, as well as fractions (“you might only want to turn half way, like 90 and 90, or half of that, like 45 and 45 and 45 and 45”).

A girl’s remarks involved ideas such as units of measure, estimation, and multiplication: “In your mind, if you thought you had to go this (holds thumb and finger apart approximately 5 cm) and you knew about that much was a turtle step (holds thumb and finger close but not touching) or 10 steps (widens the gap) you would think, if I wanna get this long that looks like 1, 2, 3, 4, 5, 6, 7...so what’s 7 times 10 and that was 70.”

Finally, a girl recognized limitations; although it “helps with numbers, Logo doesn’t help with multiplication. Once you memorize multiplication, you don’t need to know...how far the turtle went.” She then spontaneously recalled an interesting application “in geometry, when we studied lines of symmetry. Sometimes I went, if I couldn’t think of it, if it’s one like that (she drew a simple rectangular castle) and sometimes I’d have to take my pencil, pretend it’s a turtle, and say ‘Well, it goes so many’—because we’d have little

rulers saying centimeters and stuff, and they’d be that long and we’d have to take it and go like that (marking off a distance on her drawing).....”

E: “How would you pretend it’s a turtle?”

“Well, like, with your pencil, if you remembered forward 40 (she moves the pencil along the marked distance) you could think, hey you need 40 on the other side, and then you need 5 more on each side it looks like, ’til they meet. That’s the line.”

E: “The line?”

“The symmetry line.”

So, children recognized some connections between Logo work and classroom mathematics, although most of their conscious focus was on arithmetic. The important point is that they could identify such connections and could recall their mental computations and conceptualizations within the Logo context.

### Final words

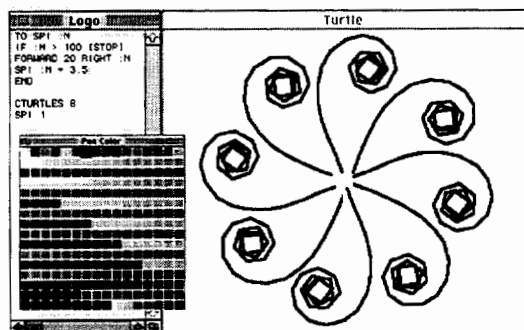
Teachers working with Logo programming should be aware of the ideas children are forming (e.g., of “circle” and “angle”) and should assist them in connecting these with traditional mathematical knowledge. Children often keep their knowledge in separate compartments.

Certainly, the degree to which the children recalled and could reproduce Logo ideas and procedures from two years earlier suggests that the turtle work had made a vivid impression. That they could articulate connections between Logo and mathematics (making, perhaps, more connections than their Logo teachers did in first grade) is also promising.

In our next column, we’ll talk about some even more surprising delayed effects of Logo. ▲

**Douglas H. Clements**, Professor at the State University of New York at Buffalo, has studied the use of Logo environments in developing children’s creative, mathematics, metacognitive, problem solving, and social abilities. Through a National Science Foundation (NSF) grant, he developed a K-6 elementary geometry curriculum, *Logo Geometry* (published by Silver Burdett, & Ginn, 1991). He is currently working with several colleagues on a second NSF-funded project,

# How Can Logo Help You Teach?



New Logo PLUS for the Macintosh lets your students explore—in glorious color!

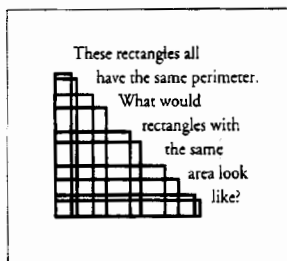


Logo is a teaching tool unlike any other. It is active and hands-on. Kids can explore, making their own discoveries about angles and measurements, patterns and shapes. With Logo, rotations, reflections, translations, and tessellations are a snap.

Students estimate, plan, and create, using a variety of problem-solving and debugging strategies. Students can figure out on their own how to draw arcs, circles and polygons, or they can use the handy built-in tools. They can explore fractions, use variables, plot points, graph functions. In short, your students can explore your entire math curriculum using Logo.

Logo teaches process, the "how-to" of math. It says "explore and see for yourself." And in learning step-by-step, students acquire the sort of knowledge that sends them confidently in many new directions.

With over 50 tools for exploring all areas of math, Logo PLUS is the natural and logical choice of a language for your classroom.



Call or write for our free *Exploring Math with Logo* and *Why Use Logo?* booklets.

**1-800-972-8200**

**Terrapin™**

400 RIVERSIDE STREET • PORTLAND, MAINE 04103  
207-878-8200 FAX 207-878-0956

*Logo languages and curriculum materials for all machines.*

*Investigations in Number, Data, and Space*, to develop a full K-6 mathematics curriculum featuring Logo. With Sarama, he is co-authoring new versions of Logo for learning elementary mathematics. One, *Turtle Math*, is available from LCSi.

**Julie Sarama** is a mathematics education doctoral student at the State University of New York at Buffalo. She has taught secondary mathematics and computer science, gifted math at the middle school level, and mathematics methods courses. Along with Clements, she is co-author of *Turtle Math* and is currently designing and programming new versions of Logo.

The authors may be reached at:  
State University of New York at Buffalo  
Department of Learning and Instruction  
593 Baldy Hall, Buffalo, NY 14260  
or via e-mail at: [clements@ubvms.cc.buffalo.edu](mailto:clements@ubvms.cc.buffalo.edu)

Time to prepare this material was partially provided by the National Science Foundation grant numbers ESI-9050210 and MDR-8954664. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

## References

- Clements, D. H. (1987). Longitudinal study of the effects of Logo programming on cognitive abilities and achievement. *Journal of Educational Computing Research*, 3, 73-94.
- Clements, D. H., & Gullo, D. F. (1984). Effects of computer programming on young children's cognition. *Journal of Educational Psychology*, 76, 1051-1058.
- Clements, D. H., & Meredith, J. S. (1993). Research on Logo: Effects and efficacy. *Journal of Computing in Childhood Education*, 4, 263-290.
- Ortiz, E., & Miller, D. (1991). *A Logo vs. a textbook approach in teaching the concept of variable*. Paper presented at the annual conference of National Council of Teachers of Mathematics. New Orleans, LA.

# Logo Online

## Logo-L, a Logo Listserv

The Logo Foundation, in cooperation with the Global SchoolNet Foundation, is now managing a Logo discussion group available to anyone with access to Internet e-mail. The objectives of this Logo discussion group are to:

1. Promote active sharing of ideas among Logo-using educators.
2. Provide a forum for questions to be asked about using Logo in the classroom. This could be of service to both experienced and novice Logo educators.
3. Provide a meeting place for Logo educators interested in collaborating on telecomputing projects involving their students sharing Logo creations.
4. Provide a forum for discussion of educational philosophy on the user of technology in education and how Logo fits into that philosophy.

You can join the Logo discussion group in one of two ways.

1. If your Internet provider subscribes to the Global SCHLnet Newsgroup Service, tune in to the SCHL.SIG.LOGO newsgroup.
2. Or you can subscribe directly to the listserv by sending an e-mail message to:

majordomo@gsn.org

with the only line in the message:

subscribe Logo-L

We look forward to chatting with you online.

Michael Tempel  
*Logo Foundation*

John St. Clair  
*Global SchoolNet  
Foundation*

## The Logo Forum on CompuServe

The Logo Forum on CompuServe is a place for young people of all ages—hobbyists, parents, teachers, teacher educators—to share the many worlds of Logo and similar languages on and off the computer; from the simplest turtle graphics exercises to complex fractals, list processing exercises, artificial intelligence, and simulations.

You will find...

- General discussions about Logo use and philosophy.
- Sixteen libraries of Logo projects, tools, and procedures, including public domain versions of Logo that can be downloaded.
- Logo papers and books for learning and teaching Logo.

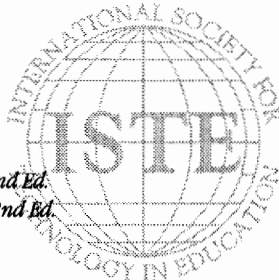
With Jim Muller as facilitator, the Logo Forum provides valuable resources and interaction with other Logo users from around the world.



# ISTE Books & Courseware Order Form

To order ISTE products advertised in this publication, find the product title in the following list and enter it on the form below.  
To receive a free Resource Guide with a complete listing of ISTE products and services, please call our toll-free number, 800-336-5191.

Product (* Indicates an ISTE-published title.)	Member Price	Nonmember Price
• <i>Introduction to MicroWorlds—A Logo-Based Hypermedia Environment</i>	22.45	24.95
• <i>Way of the Ferret—Finding Educational Resources on the Internet</i>	22.45	24.95
<i>The Whole Internet—User's Guide &amp; Catalog</i>	24.95	24.95
<i>Education on the Internet—A Hands-on Book of Ideas, Resources, Projects, and Advice</i>	25.00	25.00
<i>Hands-On Internet—A Beginning Guide for PC Users</i>	29.95	29.95
<i>How the Internet Works</i>	24.95	24.95
<i>How to Use the Internet</i>	17.95	17.95
<i>NetPower—Resource Guide to Online Computer Services</i>	39.95	39.95
<i>Realizing the Information Future—The Internet and Beyond</i>	24.95	24.95
<i>Internet Companion—A Beginner's Guide to Global Networking</i>	12.95	12.95
<i>The Mac Internet Tour Guide—Cruising the Internet the Easy Way, 2nd Ed.</i>	29.95	29.95
<i>Windows Internet Tour Guide—Cruising the Internet the Easy Way, 2nd Ed.</i>	29.95	29.95
<i>Zen and the Art of the Internet—A Beginner's Guide</i>	23.95	23.95



Receive an additional 18% discount when ordering 10 or more of the same title of ISTE-published products.

Name \_\_\_\_\_ Membership # \_\_\_\_\_

School/Business \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip/Postal Code \_\_\_\_\_

Country \_\_\_\_\_ Phone \_\_\_\_\_

## Shipping & Handling

\$0-\$15.99 (subtotal) .....	add \$4.50
\$16-\$45.99 (subtotal) .....	\$6.00
\$46-\$75.99 (subtotal) .....	\$7.00
\$76-\$100.99 (subtotal) .....	\$8.00
\$101 or more .....	8% of subtotal

GST Registration Number 128828431

Code LX1

## ORDER

Quantity	Title	Member Unit Price	Nonmember Unit Price	Total Price

## PAYMENT OPTIONS

☐ **Payment enclosed.** Make checks payable to ISTE—  
International orders must be prepaid with U.S. funds or credit card.  
☐ VISA ☐ MasterCard ☐ Discover Card Expiration Date \_\_\_\_\_

☐ **Purchase Order enclosed.** Please add \$4.00 for order processing—  
P.O. not including \$4.00 fee will be returned.

☐ **C.O.D.** for U.S. book orders only. You will pay UPS the total upon delivery by check or cash—  
ISTE will add \$4.50 order processing.

☐ **Airmail.** International orders for Books & Courseware are sent surface mail—  
ISTE will bill you the additional shipping charge for airmail.

☐ Send me ISTE membership and subscription information.

☐ Send me a free ISTE catalog.

Deduct 18% on ISTE-published titles if ordering quantities of 10 or more of the same title

**SUBTOTAL**

-

**SUBTOTAL**

Shipping and Handling (see box above)

+

Add Additional 5% of SUBTOTAL if shipped to PO Box, AK, HI, or outside U.S.

+

Add 7% of SUBTOTAL for GST if shipped to Canada

+

If billed with purchase order, add \$4.00; If COD, add \$4.50

+

**TOTAL**

=

ISTE • 480 Charnelton Street, Eugene, OR 97401-2626 • Order Desk 800-336-5191 • Fax 503-302-3778\*

(\*Effective November 1, 1995, our area code will change to 541)



# iste@oregon.uoregon.edu

The wide world of Internet. It's growing larger and making our world smaller. If you're not already an Internet user, you probably want to be one.

As you prepare to keyboard your way into the Internet fast lane, ISTE can be a big help to you. We continue to add Internet books to our mix of publications available to educators.

The ISTE Internet collection includes the following titles:

- Way of the Ferret—Finding Educational Resources on the Internet, Revised Edition
- Education on the Internet—A Hands-On Book of Ideas, Resources, Projects, and Advice
- Hands-On Internet—A Beginning Guide for PC Users
- How the Internet Works
- How to Use the Internet
- NetPower—Resource Guide to Online Computer Services
- Realizing the Information Future—The Internet and Beyond
- The Internet Companion—  
A Beginner's Guide to Global Networking, Second Edition
- The Mac Internet Tour Guide—Cruising the Internet the Easy Way,  
Second Edition
- The Whole Internet—User's Guide & Catalog, Second Edition
- The Windows Internet Tour Guide—  
Cruising the Internet the Easy Way, Second Edition
- Zen and the Art of the Internet—A Beginner's Guide

These books are valuable keys for getting your computer started and on its way via the Information Superhighway. Keep in touch for information on our newest titles.

Order Phone \_\_\_\_\_ 800/336-5191  
Fax \_\_\_\_\_ 503/302-3778  
e-mail \_\_\_\_\_ iste@oregon.uoregon.edu

Look for our World Wide Web page—<http://iste-gopher.uoregon.edu:80>

## ISTE BRINGS THE WORLD OF TECHNOLOGY CLOSER TO YOU.

By drawing from the resources of committed professionals worldwide, ISTE provides support that helps educators like yourself prepare for the future of education.

ISTE members benefit from the wide variety of publications, specialized courseware, and professional organizations available to them.

They also enjoy exciting conferences, global peer networking, and mind-expanding in graduate level distance education courses.

So if you're interested in the education of tomorrow, call us today.

AL SOCIETY FOR



**International Society for Technology in Education**  
*Customer Service Office*

480 Charnelton Street, Eugene, OR 97401-2626 USA

Phone: 800/336-5191 Fax: 503/302-3778

America Online: ISTE AppleLink: ISTE

CompuServe: 70014,2117 Gopher: iste-gopher.uoregon.edu

Internet: iste@oregon.uoregon.edu

WE'LL PUT YOU IN TOUCH WITH THE WORLD.