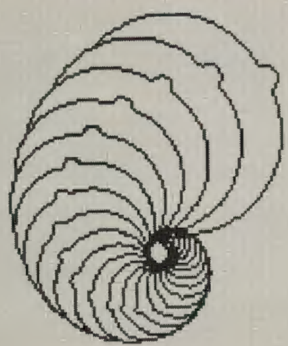
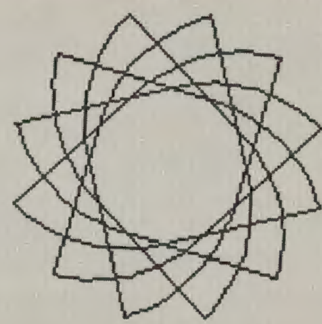
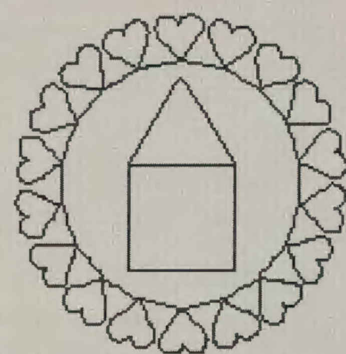
LOGO EXCHANGE

The Magazine for LOGO Activities Worldwide

ISSN 0888-6970 VOLUME 5 NUMBER 3 NOVEMBER 1986







Meckler Publishing Corporation

University of Virginia
Summer Logo Fellowship Program
1986 - 1987

What is the UVA Summer Logo Fellowship Program?

An opportunity for educators to come to the University of Virginia for a three week summer period of individual Logo related study.

What are the objectives of the Logo Fellowship program?

The objectives are to:

Encourage the development of innovative Logo projects in all grade levels and subject areas

Disseminate Logo projects produced by the fellowship program

Provide fellowship recipients with time and resources for study, work, and growth

When does the fellowship program operate?

The next fellowship period of study will begin June 1987. The application cycle for this period begins in October 1986.

How is the fellowship program supported?

The program is made possible by a series of grants from Logo Computer Systems Incorporated (LCSI) to the University of Virginia. From these grants, support for travel, room, board, graduate credit hours, and a cash award are provided to each fellowship recipient.

Who may apply for the UVA Summer Logo Fellowship PRogram?

Teachers of K-12 students, college and university teachers,and teacher educators who have used Logo on a regular basis for the past year are eligible to participate.

What other qualifications are important?

Fellowship recipients must possess exceptional communication skills and initiative, be able to work well with others, and be highly motivated about the possibilities for using Logo in education.

What is the application process?

Applicants should write immediately to the University of Virginia Summer Logo Fellowship Program, Curry School of Education, Ruffner Hall, Charlottesville, VA 22901, requesting the application forms. Applications will be mailed in late October. Completed applications are to be returned to the University of Virginia before December 20, 1986. A selection committee will evaluate the applications and choose a group of finalists, from which the two fellowship recipients for 1987 will be named.

What are the fellowship expectations?

A Logo fellowship recipient is expected to plan and begin carrying out a self-designed Logo-related project during the fellowship period. Tom Lough, Glen Bull, Paula Cochran, and others will serve as consultants to each fellowship recipient. At the conclusion of the summer study period, the recipient would be expected to submit a reasonable plan for completing the project, and for dissemination of the project.

What is a typical fellowship project?

Projects are conceived and planned by the fellowship candidates themselves. Typical projects could include innovative Logo units related to particular subject areas, teaching or training modules, informal educational research, and course development. Projects carried out under the current series of grants must be based on LCSI Logo products.

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CONTENTS

International Logo News

Cover: The Logo house and heart design was contributed by Carol Goodman, a K-7 teacher of computers at Campbell Hall, an independent school in North Hollywood, CA. The design was inspired by a Logo song published in the November 1984 issue of *The National Logo Exchange* newsletter.

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From the Editor

by Tom Lough

Whispering Hope

"Hey! This is what my son has just started to learn in the fourth grade!"

The excited comment was made by one of my students at Piedmont Virginia Community College during the introduction to Logo for my physics classes. "Mine, too!" another chimed in.

This realization gave an extra specialness to the lab activity. In addition to their own personal explorations, the other students delighted in watching what the two "Logo parents" were drawing. A cheer went up when their designs came out on the printer.

Somewhere in Charlottesville, there soon would be a couple of very proud refrigerators! After all, how often have you seen Logo school work of both parents and children displayed side by side?

In itself, the experience was heartwarming. But let's also think about what caused it to happen. In a word, Logo is evolving.

I believe that such events will soon be commonplace. As Logo's use continues to spread (Minnesota has purchased LogoWriter for all its elementary schools, for example), a majority of children in developed countries and a sizeable portion of those in developing countries will have had the opportunity to work with the turtle.

But Logo is also making slow but steady headway in the postsecondary schools everywhere. (I just received a letter from a physics professor in China who wants to incorporate Logo into the curriculum there!) This is aided by the appearance of Logo books with more sophisticated applications. As more and more "adult" courses begin to appropriate Logo as part of the regular medium of instruction, the opportunity for parents and children to consult each other will increase.

Imagine this: Mom is working on an assignment in her college geometry course. She is using Logo to conduct an exploration of angles and parallel lines for a class project. But the internal and external nature of the angles is puzzling when she uses the turtle. When she wants to draw a 120 degree angle, she has to use RIGHT 60 to set it up.

"Whatcha doin', Mom?" The query is squeezed out between peanut butter and jelly sandwich munches. After a brief parental explanation, the 12-year-old Logo "consultant" makes a helpful suggestion. "Why not just turn RIGHT 180 first? Then the LEFT 120 will be the angle you want."

Isn't it a wonderful thing to contemplate? In these times of peril for the family as an institution, Logo can provide an opportunity for a cooperative and enjoyable experience.

In this period of quiet, steady Logo growth, I believe that we will see quiet, steady changes in education, also. No, nothing like a "revolution;" the present system is much too firmly entrenched for that. But, at the personal teaching level, as more and more individuals learn of Logo's potential, changes in attitude, style, and philosophy can be gently encouraged and supported. Not with a bang, but a whisper.

FD 100!

Tom

Logo Integration: Working towards the Ideal

by Dave Chesebrough

David's eyes were telling me that my "guest appearance" to introduce the use of variables held nothing new for him.

Mary Ellen Wampler's sixth grade math group had been challenged to create a FILL procedure to color the different rooms in their Logo created scale drawings. I had planned to use the challenge to bring variables into their Logo use, since we had not presented variables yet. It seemed that these students were way ahead of me.

I stopped and asked, "How many of you are using variables already?" Almost every hand went up. Peter confidently proceeded to show me he had "discovered" how to use variables for length, width, and color in his FILL procedure - something far more sophisticated than we had anticipated.

This is just one of many examples of why Logo has been the language (and educational computer environment) of choice for over four years at Sewickley Academy, in Sewickley, PA. We would like to think we have a model program of using Logo to enhance the quality of education we offer at our school.

No One Said It Was Easy

We have found, though, that it is not easy to reach this point. Implementing the use and philosophy of Logo on a schoolwide basis, as well as tying into the way students use their home computers, is a challenging task, to say the least.

Sewickley Academy is a private N - 12 school outside of Pittsburgh with a population of about 580 students. The school has a part time computer coordinator for the entire school (yours truly), and a part time Senior School computer teacher / coordinator. We have one lab for Lower / Middle School use and two labs for the Senior School, with about a dozen other computers distributed around the school for individual classes, teacher use, and the like. There are enough Apple computers in the labs to provide one Terrapin Logo station for at least every two students. We also use word processors, data bases, science simulations, and other application programs.

Although students are exposed to Texas Instrument's Logo in nursery school and kindergarten, we wait until third grade to start our formal Logo program, combining it with keyboarding skills. Logo "classes" then continue through the sixth grade with sessions for the entire class at least once a week. An early decision was made that all teachers would conduct the Logo computer sessions, with the hope that they would better see how to integrate its use into their classes.

We have struggled through several approaches to supporting the teachers and providing some direction for the Logo studies and investigations. The classroom teachers have received a number of inservice sessions over a period of several years. However, as the program has progressed, it has become evident that teachers who are not immersed in Logo have a difficult time retaining their skills, much less advancing them. As the students have gotten three years of Logo under their belts, some of the teachers have quickly found themselves feeling inadequate, despite their sincere efforts to "stay up."

The Sewickley Solution

The best solution to date has been the development of a team teaching approach, where I act as consulting "Logo expert" and sometimes second instructor in the lab. In addition, I found it necessary to create our own support materials, as nothing on the market was suitable. We wanted activities and resources to support the teachers with guidance in presenting Logo skills, yet continue with the exploratory spirit of Logo as skills were mastered.

The materials I developed begin with a collection of sequenced activities which lay out basic computer and Logo skills in levels, followed by extension activities for each level. These acgivities consist of exploring ideas, project challenges, Logo "tips," and extra skills for those interested students.

The goal is to have each student reach a certain level of competence with Logo skills which are appropriate and comfortable for them individually. Then we want to release the students to explore ideas of their choosing or to pursue project goals. After a period of time when the recently mastered Logo skills have been used to their maximum (from a time or interest standpoint), new skills are introduced and practiced. Then the students are launched off exploring from a new level. We have found that most students stagnate and turn away from Logo without some support, ideas to build on, and direction.

Following such an approach, the most interested and talented students are able to delve into particular challenging areas appropriate to them. At the same time, other students can explore ideas supported at much less involved skill levels. It is neither necessary nor appropriate to constantly push a student to higher skill levels, unless it is of the student's choosing. I am believing more firmly than ever that students should be allowed to explore Logo through its breadth around one skill level, or alternatively through its depth of skills - *whichever suits that particular student at the time.*

Pursuing the use of Logo as an exploratory tool is just one way in which we see its usefulness. We are now starting to get better integration into classwork with our own support materials in place. Last year, one fourth grade class researched Martin Luther King and made a Logo documentary of text and pictures of his life. Each frame of text and the corresponding picture were done as procedures which I organized with a "slideshow" driver procedure. In this class, we used the Logo editor much as a word processor.

A fifth grade math class converted scale drawings of their homes to Logo pictures (using procedures) and then wrote a FILL procedure which filled each room with different colors. A lot of good math and Logo concepts came from this one project. We have had classes make drawings and procedures to match their reading and math activities, and we have other ideas in the works, such as more use of scientific microworlds.

Higher and Higher

We don't stop in the lower school, though. We are making more frequent use of Logo in the science program in seventh and eighth grades. In the past few years, we have completed projects of solar system research for a Logo guide through our planets, used a Logo program for cartography, programmed unit cells of crystals (showing growth), explored a frictionless world (the classic dynatrack), and used little utilities such as temperature conversion procedures.

At the senior school level, we use several weeks of Logo at the start of our structured programming class. Logo enables the student easily to learn modularity, understand the use of an editor, and explore programming concepts with quick graphic response. Teachers at the school are now investigating the use of Logo in the physics and mathematics courses as well. One challenge with the senior school program is to deliver the students to the teachers with the level of Logo competence needed for the style and depth of exploration they would like. We are still grappling with this problem.

Logo at Home

Sewickley Academy is launching an innovative and aggressive program of getting as many Apple computers into the homes as possible to support the innovative uses of computers in our overall program. I am promoting to parents that the Logo language be purchased with every home computer. During the 1985-86 school year, I sponsored several Logo awareness sessions for parents (explaining our use and providing hands on time), and then coordinated a purchase program for the parents. I was able to receive a discount from Terrapin, Inc., for our bulk order. Plans are to continue to expand on this cooperation with parents. We want to have students take their Logo projects and ideas home where they can explore more without the constraints of limited access to school computers.

Our program is still not where I would like it. We are just now becoming creative with the integration ideas. Too many of the teachers still feel weak in the finer points of Logo. Some students get "tuned out" early. We are just now using the complete set of support materials I developed. However, we have come a long way since the start and are working well towards Logo becoming THE exploratory computer language throughout the school.

(Ed. note: Dave made a presentation at Logo 86 about the Sewickley approach and materials. To obtain a copy of the handouts from that presentation, send a long stamped self-addressed envelope to Dave Chesebrough, Sewickley Academy, Sewickley, PA 15143. Also, the Sewickley Logo material is scheduled for publication by J. Weston Walch in early 1987. For more information, call the publisher at (800) 341-6094.)

Dave Chesebrough is the computer coordinator for Sewickley Academy and the author of the Logo Success Kit.

Tipps for Teachers

by Steve Tipps

Fraction Line Frolics

Although fractions appear in many ways in everyday life, the mathematical ideas of fractions, ratios, proportions, and division confuse and distress many students, both young people and adults. During a calculator workshop recently, several students were quite amazed that the fraction 1/2 was the same as 1 divided by 2. But why were they puzzled? What kind of experiences had they had with fractions previously?

Working with fractional areas of pies, cakes, and cookies is effective. I call this level of fraction work nominal. Students learn to name the parts of the whole. Certainly, calling the names has worth. But students seldom seem to get beyond that level. They don't seem to have experiences with ratio ideas, for example. How might Logo be used to provide some more worthwhile experiences?

Last month in "Tipps for Teachers," Logo was used to create fractions and fractional parts of regions. Another way of demonstrating the values of fractions is with a Logo number line. The fraction number line looks like an ruler with many subdivisions. With the Logo fraction tools, students can explore different fraction and different units.

Fraction Line Tools

The first tools which are needed will set the position of the turtle and draw the line. For convenience of most most screen sizes, the line has been made 200 turtle steps long.

```
TO SETUP
CLEARSCREEN
PENUP BACK 20 LEFT 90
FORWARD 100 PENDOWN RT 180
END
```

```
TO DRAW.LINE
SETUP
FORWARD 200 BACK 200
END
```

DRAW.LINE can also be made with the FORWARD.BACK or FB procedure which is variable. This makes the procedure quite useful in other procedures as well.

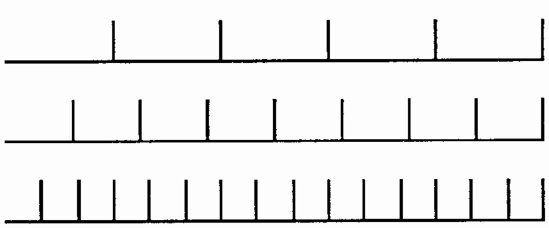
```
TO FB :DISTANCE
FORWARD :DISTANCE BACK :DISTANCE
END

TO DRAW.LINE
SETUP FB 200
END
```

After the line is drawn with DRAW.LINE, the next task is to divide the line into equal parts. Two procedures are used for this task. MARK makes tick marks. MARK.LINE creates a number of equal size units along the top of the line. The turtle goes back to the starting place.

```
TO MARK
LEFT 90 FB 15 RIGHT 90
END
```

```
TO MARK.LINE :NUMBER
MAKE "UNIT 200 / :NUMBER
REPEAT :NUMBER [ FORWARD :UNIT MARK ]
BACK 200
END
```



MARK.LINE can be used to mark the line into many units. By changing the color of the line each time, the students can explore the possible multiples.

MARK.LINE 2 creates two equal divisions. Using the command MARK.LINE 4 subdivides the units into quarters. MARK.LINE 8 and MARK.LINE 16 extends the dividing process. Beginning with MARK.LINE 3 or MARK.LINE 7 or MARK.LINE 25 is a demonstration of division by many numbers. Sometimes students fail to understand that fractions and division are not limited to halves, thirds, and fourths.

Fraction Turtle

Exploration of equal units is a prelude to using the turtle to show fraction values on the number line. A new Logo procedure makes the turtle into a fraction turtle.

```
TO FRACTION :NUMERATOR :DENOMINATOR
FORWARD :UNIT * :NUMERATOR / :DENOMINATOR
LEFT 90
FORWARD 10 BACK 20 FORWARD 10
RIGHT 90
BACK :UNIT * :NUMERATOR / :DENOMINATOR
PRINT :NUMERATOR / :DENOMINATOR
END
```

Before using FRACTION, use DRAW.LINE and MARK.LINE to set up a new line. The number of equal units is unimportant to Logo, but, for easy view, the fractions represented by MARK.LINE 2, 3, or 4 might be good.

The FRACTION procedure requires two input numbers to designate the desired fraction. The first input gives the numerator of the fraction and the second the denominator.

FRACTION 1 2 is one half.
FRACTION 2 5 is two fifths.
FRACTION 7 16 is seven sixteenths.

In response to the inputs given, the turtle moves along the line to the value of the fraction of the unit. The size of the unit is taken from the :UNITS global variable set up in MARK.LINE. The turtle makes a mark on the line, then returns to its starting position. Finally, the decimal value of the fraction is printed on the text screen.

```
?DRAW.LINE  MARK.LINE 5
?FRACTION 3 5
0.6
```

One, More or Less

FRACTION relates the common fraction to a place on the number line to a decimal value. These three aspects make it excellent for comparing the value of the fraction in a visual as well as a numerical way. Students often have a difficult time seeing that 1/2 and 2/4 and 3/6 and 15/30 are all the same value. But the fraction turtle keeps going back to the same place and printing .5 for each one. Values for 1 are also important to explore with a variety of inputs. Students need to see that FRACTION 10 10, FRACTION 13 13, FRACTION 72 72, and the hundreds of others are all equal to 1. Fraction equivalents are one excellent use of FRACTION.

Comparing unequal fractions is another use of FRACTION. Often textbooks have a work page which asks students to place "<" (less than) or ">" (greater than) between two fractional expressions. Many students have no feeling for the relative size of the fractions. Before teaching them how to get the least common denominator and multiplying, let them explore inequalities as FRACTION moves along the line. Which fraction is greater or less is determined by the position of the turtle. Before moving the turtle, students can estimate which is the larger value. Then, use the fraction turtle to find out which fraction was larger.

ESTIMATE	EXPERIMENT	REWRITE
1/2 ___ 1/3	1/2 ___ 1/3	.5 > .333
3/8 ___ 1/5	3/8 ___ 1/5	______
3/7 ___ 4/9	3/7 ___ 4/9	______
3/5 ___ 4/7	3/5 ___ 4/7	______
6/11 __ 5/9	6/11 __ 5/9	______

The decimal values of the fractions are also printed for comparison. The decimal values can be rewritten as another way to express the inequality.

Improper fractions are often confusing for many students. In fact, some students vow that it is impossible to put a fraction such as 5/3 on the number line. They have only experienced fractions with the numerator smaller or equal to the denominator.

With the FRACTION procedure, students are able to see exactly what happens with fractions such as 5/2 or 13/4. They will be surprised and perhaps have to rethink their understanding if the improper fraction requires more units than they have marked on the line.

Where Is My Fraction?

A good guessing game is also possible with the fraction line. Draw a clean fraction line using LINE and MARK.LINE. Then, the PUT.RANDOM procedure zips the turtle to the location of an unknown fraction. The object is to guess the fraction and its decimal value.

```
TO PUT.RANDOM
FD :UNIT * (1 + RANDOM 5) / ( 1 + RANDOM 5)
END
```

The positions in PUT.RANDOM are limited to halves through fifths. Guessing the position may not be too hard after some practice. (Ask students why the 1+ is used in both the numerator and denominator. Is it needed in both places for the same reason?)

There are several ways to check the guess. One way would be to MARK the position, the move back to zero. Then use FRACTION to try to hit the marked position. A ZERO procedure is easy to write. Of course, the zero position is in accord with the original line length of 200.

```
TO ZERO
SETX -100
END
```

Another way to check the fractional guess would be by asking the turtle where it is, fractionally speaking. The WHERE? procedure reveals where the turtle is.

```
TO WHERE?
PRINT [ THE TURTLE IS LOCATED AT ]
PRINT (XCOR +100) / :UNIT
END
```

This value is compared to the fraction printed in a simple PRINT command. If the guess was 3/5 and the turtle was actually at 3/4, the activity would have three parts: putting the turtle in a random spot, printing the value of the guess, and asking where the turtle actually is. Comparison of the fraction input to the decimal answer is beneficial.

```
?PUT.RANDOM
?PRINT 3/5
0.6
?WHERE?
0.75
```

After several guessing experiences, the range of possibilities in PUT.RANDOM could be adjusted to be more difficult.

Fractions, More and Less

Another activity for the fraction line is adding or subtracting fractions. The FRACTION procedure always moves the turtle back to zero on the number line, but PUT.RANDOM stays at the place representing the fraction. A new procedure to maintain the position of a fraction is needed.

```
TO ADD.FRAC :NUMERATOR :DENOMINATOR
FD :UNIT * :NUMERATOR / :DENOMINATOR
END
```

ADD.FRAC 1 4 moves the turtle one fourth of the way along the the first unit. Another ADD.FRAC 1 4 causes the turtle to scoot to the position 1/4 + 1/4 or 1/2. Now the student can add fraction after fraction and watch the result. The result can be estimated on the number line. The exact value can be calculated from the position of the turtle with WHERE?

The location of the turtle is printed in decimal form. Therefore, when you ADD.FRAC 1 2 and ADD.FRAC 1 6, WHERE? produces 0.666667. If the students want to subtract, have them create a SUB.FRAC procedure similar to

ADD.FRAC but with BACK instead of FORWARD. (Or create a MOVE procedure like ADD.FRAC which can be used for adding or subtracting depending upon whether the input is positive or negative.) Use ZERO to get back to zero for a new problem.

To Multiply or Divide

These fractions line tools are intended to extend the experiences student have with fractions. They do not replace concrete manipulatives, but they may allow for more rapid experimentation with many units and many fractions. Repeated manipulation of fractions is essential for firm understanding.

Exploration is not over when students have drawn lines, marked them, seen fractions marked and converted, guessed where the turtle is, or added values. While working with the fraction line tools, students should be challenged how to show multiplication and division of fractions as well as addition and subtraction. I will leave this as a challenge to you now...

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

Teacher Feature

by Rebecca Poplin

Featuring: Paola Williams

Imagine if you can the lovely Hawaiian island of Oahu. On a serene rolling campus in a residential part of Honolulu, there's a beautiful and special pri- vate school called Punahou. Serving a multinational population of about 3700 students K-12, Punahou is a model of computer use and the scene of one of the earliest Logo implementations.

It is in this environment that Paola Williams is the computer teacher / coordinator for grades K-8. Although all Punahou elementary teachers use com- puters and many are experts, Paola is unique in that she spends all of her day working with teachers, children, and computers. In the Kelley Computer Center, Paola works with about 900 K-7 students during the year and consults with eighth grade teachers. She sponsors a seventh and eighth grade computer club which will put out a junior high newsletter (using the computer, of course). As if those jobs don't keep her busy enough, Paola also conducts teacher workshops and develops new curriculum during the summer!

A Productive Summer

It is the summer curriculum development that has been Paola's most recent exciting enterprise. The purpose of the project was to develop curriculum related to math and technology. Working with math teacher Ann Kennedy, Paola incorporated computers and calculators in four special math units. The results of their work are being used in the sixth grade at Punahou this year. They conducted a follow-up inservice in October and will work on adding several more units to the first four. The units include off-computer activities, field trips, and investigations as well as computer and calculator activities and tools. In addition to Logo, Paola and Ann used the PFS: series of applications to enrich the curriculum.

Bull or Bear?

One of the projects was an extensive study of the stock market. Students studied stocks, devel- oped their own portfolios, and charted their pro- gress. The teachers and students developed their own data base using Logo to store information about the stocks they chose. A spreadsheet program they designed calculated percentage of gain or loss.

To Market, To Market

A second unit of study involved a market basket analysis problem. Students visited the computer facilities at a grocery store, outlined the way they would use the spreadsheet, and did a lot of unit pricing. Students discovered much to their surprise that items in convenience stores are gen- erally more expensive than supermarkets despite their smaller size. They also found that the same chain in different locations in Honolulu charges different prices for the same item. Theories about this phenomenon were abundant.

Home Financial Management

Correlated to the market and stock market units was a study of using the computer for management of home finances. Students determined the family structure, decided whether their spouses had careers, and drew jobs out of a box. Then they used computer and calculator programs to unravel the family budget. Not surprisingly, the sixth graders tended to be some-what unrealistic about money, especially about how far it will go.

Dream Bedroom

A fourth project designed during the summer was that of the dream bedroom. Students created bedroom floor plans using Logo and then investi- gated costs of their designs. Comparisons were done between types of floor coverings. Students had to calculate the square footage and analyze the information gathered about floor covering costs to do the comparisons. Paola created Logo tools to assist the calculations. Most of the students had a swimming pool in the middle of the bedroom floor!

Just the Beginning

The four units in math and technology were so much fun that more are planned. Health appraisal, reaction times, nutritional information, and travel are just a few of the topics Ann and Paola plan to probe. In the meantime, Paola is working with the new LogoWriter software Punahou has purchased. She is developing language arts projects in Logo doing plurals and teaching the computer the rules of English and helping students use a wide variety of tools. If you are interested in further information about the units Paola and Ann developed, please write to:

Paola Williams
960 Honokahua Place
Honolulu, HI 96825

If you know of teachers who should be featured in this column, please write to Rebecca Poplin, 2421 Fain Street, Wichita Falls, TX 76308

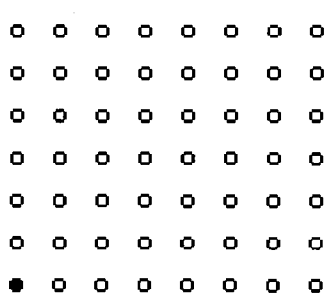
Rebecca Poplin uses Logo to teach junior high computing and mathematics in Wichita Falls, TX.

Teaching Tools

by Glen Bull and Paula Cochran

Geoboard Tools

A geoboard is a wooden board with rows of nails or pegs. Rubber bands can be stretched around the pegs to form geometric figures. Geoboards are used as laboratories for the exploration of patterns, length, size, color, and coordinate geometry.



Logo can be used to create tools which can facilitate exploration with geoboards. In the example that follows, Logo does not replace the hands-on activity, but complements it.

Precomputer Activities

In one fifth grade math book we explored, coordinate geometry was used to introduce students to the concepts of graphing, symmetrical figures, congruent figures, and similar figures. The book supplied lists of coordinate pairs for students to translate into drawings on graph paper.

An alternate activity would be for students to develop their own figures using a geoboard. A geoboard has the advantage that a line is easily moved to see a different effect. Exploration is encouraged because the points of the rubber band can be shifted to produce a different figure.

After a design on the geoboard has been completed, the pattern of pegs can be translated into a list of numbers (coordinate points) by the students. For example, in the figure on the preceding page, the description of the upper right-hand peg would be of the form [X Y], where X is a number telling how many pegs in the horizontal direction to count from a reference (perhaps the lower left peg), and Y tells how many to count in the vertical direction. These lists of numbers permit students to go from one medium to another -- from rubber bands and pegs to codes on a piece of paper. Going from one medium to another is the equivalent of playing turtle in Logo. Moving your body through the steps that the turtle will take on the screen is a form of associated learning.

There are several ways that this type of learning can be encouraged. One group of students can design a figure on the geoboard and translate it into a list of numbers. Then a second group of students can attempt to use the list of numbers to recreate the original figure. Mistakes can come at two places: in the encoding of the original design into numbers, or in the decoding of the numbers by the second group.

Two groups of children communicating in this way provide a metaphor for more than math. Recent research suggests that cooperative learning can be more effective than individual efforts. The discussion of these efforts can continue into social studies class, and the study of negotiation and diplomacy. Even when all parties are acting in good faith, the original design does not always get transmitted accurately.

The lists of numbers used to code geoboard coordinates can also be used as a means of information storage and retrieval. It is possible to save a particularly good design and recreate it later. The idea of storing favorite figures in a notebook, and reproducing them later extends the idea of shifting from one medium to another. It also shows the power of coding.

After students have worked with geoboards and developed a repertoire of designs translated into numbers, other concepts can be introduced. Students may spontaneously express a desire to change the scale of a figure. For example, can a small eagle be turned into a large eagle? One approach is to tinker with the rubber bands on the geoboard. When a small figure is turned into a large figure, is there is any correspondence between the two lists of coordinate numbers?

A teacher can guide students into these questions, and suggest ways of arranging the figures to make the relationships more evident. With advanced students, the question can be posed: "Is there a reliable method for changing a small figure into a large one?" This leads students in a search for formulas and scale factors which can be used to multiply each number in a list to enlarge the design.

There are a number of other transformations which can be applied. For example, what is required to shift a figure left or right, or up or down on the geoboard? What happens to the coordinates of the figure if this is done? What is required to flip a figure and reverse the direction it faces, or to rotate it 90 degrees? These simple questions are easily expressed in English. Answers may take longer. In the process of searching for them, students may encounter the notions of variables, multiplication and scaling, offset, and a host of other ideas.

Logo Tools: A Third Medium

When the students have developed a number of coordinate lists that represent geoboard designs, and have begun to ponder the concept of transformations such as scale and direction, the computer can be introduced as another tool and used in several ways. For example, a spreadsheet, such as VisiCalc or its successors can be used to reduce the computational overhead in manipulating the numbers.

Logo can also be used to facilitate exploration of geoboards. Thus far, we have discussed two media: rubber bands stretched between pegs on a geoboard, and lists of numbers which represent the positions of the pegs. The graphics screen in Logo provides a third medium.

Here is a Logo tool for graphing a list of coordinates. It consists of two procedures: the master procedure is called GRAPH, with a subprocedure called GRAPH.WORK, which does all of the work.

> If you are using Terrapin Logo, omit the brackets around [STOP] in GRAPH.WORK. You will also need to define the SETPOS procedure found at the end of the column.

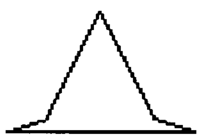
```
TO GRAPH :LIST
PU SETPOS FIRST :LIST
PD GRAPH.WORK BF :LIST
END

TO GRAPH.WORK :LIST
IF EMPTYP :LIST [ STOP]
SETPOS FIRST :LIST
GRAPH.WORK BF :LIST
END
```

These are Logo tools. It is not at all necessary that the children understand how the procedures work internally, any more than it is necessary for them to understand the assembly language code that makes up FORWARD or BACK. The tools can be used as though they were built-in commands.

(Many versions of Logo allow a teacher to bury tool procedures.) The procedure works like this:

?GRAPH [[0 0] [15 5] [35 45] [55 5] [70 0] [0 0]]

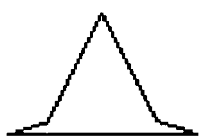


A list of coordinates can be put in the form of a procedure. This eliminates the necessity of retyping the list every time it is used, and helps with debugging.

```
TO HAT.LIST
OP [ [0 0] [15 5] [35 45] [55 5] [70 0] [0 0] ]
END
```

To produce the same graph as before, type:

?GRAPH HAT.LIST



The coordinate numbers can be printed as well as graphed.

?PRINT HAT.LIST
[0 0] [15 5] [35 45] [55 5] [70 0] [0 0]

Transformations

The figure we provided is a small one. If you want to make it larger, here are some additional Logo tools which allow you to magnify any figure. MAGNIFY.X stretches the figure horizontally, and MAGNIFY.Y stretches the figure vertically.

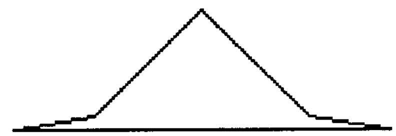
You need to be careful typing in the commands for the MAGNIFY.X and MAGNIFY.Y procedures. Experiments with our proofreaders have demonstrated that it is all too easy to make a typing mistake with these procedures, and reverse or leave out an FPUT, FIRST, or BF. (In Terrapin Logo, it is necessary to omit the brackets around [OP []].)

```
TO MAGNIFY.X :X :LIST
IF EMPTYP :LIST [ OP [ ] ]
OP FPUT (FPUT ((FIRST FIRST :LIST) * :X) BF
FIRST :LIST) MAGNIFY.X :X BF :LIST
END
```

```
TO MAGNIFY.Y :Y :LIST
IF EMPTYP :LIST [ OP [ ] ]
OP FPUT (LPUT ((LAST FIRST :LIST) * :Y) BL
FIRST :LIST) MAGNIFY.Y :Y BF :LIST
END
```

The magnification tools can be used to change the scale of a figure. For example, to stretch a figure sideways, use the MAGNIFY.X tool. You need to provide as input the amount by which you want to magnify and the list of points describing the object. The following example doubles the width of the hat figure.

?GRAPH MAGNIFY.X 2 HAT.LIST



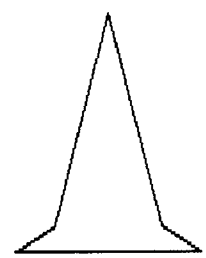
Stretching the width of the figure can be used to produce some interesting effects. It is like working with Silly Putty. Once students produce a satisfactory change that they wish to keep, the new coordinate numbers can be recorded. Using the PRINT command with MAGNIFY.X also demonstrates that it has doubled the value of every horizontal coordinate. In other words, the number 15 in the second pair becomes 30, the number 35 in the next pair becomes 70, etc.

?PRINT HAT.LIST
[0 0] [15 5] [35 45] [55 5] [70 0] [0 0]

?PRINT MAGNIFY.X 2 HAT.LIST
[0 0] [30 5] [70 45] [110 5] [140 0] [0 0]

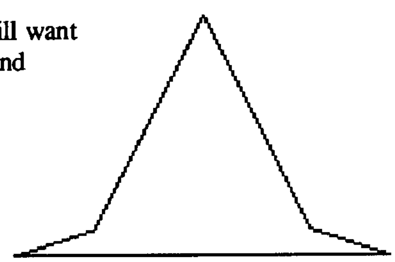
The MAGNIFY.Y procedure stretches the height of a figure.

?GRAPH MAGNIFY.Y 2 HAT.LIST



MAGNIFY.X and MAGNIFY.Y can be combined to stretch the figure in both directions at the same time.

?GRAPH MAGNIFY.X 2 MAGNIFY.Y 2 HAT.LIST



Sometimes you will want to change the horizontal and vertical dimensions of a design by different ratios. In those cases, the MAGNIFY.X and MAGNIFY.Y tools are handy. However, if you want to change the overall size, the SCALE tool combines both MAGNIFY.X and MAGNIFY.Y to change the entire scale of the figure at once, and saves typing, too.

```
TO SCALE :SIZE :LIST
OP MAGNIFY.X :SIZE MAGNIFY.Y :SIZE :LIST
END
```

?GRAPH SCALE 2 HAT.LIST

Despite the names of MAGNIFY.X and MAGNIFY.Y, these tools can be used to reduce the dimensions of an object as well as enlarge them. Try them using numbers such as 0.5 and 0.25.

That raises a second issue. You do not have to call the procedures MAGNIFY.X and MAGNIFY.Y. We chose those names because we thought they were descriptive. However, they also require a bit of typing. They could also be GROW.X and GROW.Y or anything else meaningful to your students.

Back to the Geoboard

Once a design has been transformed and changed on the Logo screen, it is time to go back to the geoboard. Students need the new lists of coordinates. These can be obtained using PRINT.

```
?PRINT SCALE 2 HAT.LIST
[0 0] [30 10] [70 90] [110 10] [140 0] [0 0]
```

These numbers can be copied on a piece of paper. They can also be run off on the printer. This may be useful for elaborate figures which produce long lists of coordinates.

It is important to test the new coordinates with the old medium of pegs and rubber bands. Going back and forth between the medium of the Logo screen and the medium of the geoboard makes the students examine the numbers used to code the transition. In a sense, these numbers are a bucket which can be used to carry the design from the computer to the geoboard. It is also important to go between the different media for the same reason that it is important for a child to play turtle by moving his or her body through space. It is possible to understand an idea in more than one way, and working with different dimensions helps children to make connections. Musicians, artists, and athletes understand that knowing and doing are not the same thing.

Procedures Required for Terrapin Logo

If you are using Terrapin Logo, you will need to type in the following SETPOS procedure.

```
TO SETPOS :LOCATION
SETXY FIRST :LOCATION LAST :LOCATION
END
```

If you are using Version 1 of Terrapin Logo, you will also need an EMPTYP procedure.

```
TO EMPTYP :LIST
OP :LIST = [ ]
END
```

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TO BEGIN :PROCEDURES

by Elaine Blitman
and Barbara Jamile

"Look what I made!" rings out as children create patterns and pictures with turtle graphics. Wanting to preserve or share this work soon leads to the need for instruction in procedure writing which goes beyond knowing how to use TO and END. To avoid poorly written procedures which resemble a run-on sentence, teach and build procedure writing skills.

Writing Procedures

A well-written procedure is concise, easy to debug, and does a specific job. Some suggestions for good habits:

1. Choose a name that is descriptive and brief. A meaningful name such as TRIANGLE or SAIL is more easily remembered than a nonsense name of ZZXZ or PHEB. Brevity cuts down on typing time. TRI may be preferable to TRIANGLE, or BOAT to EXCALIBUR.SPEEDBOAT.

2. Each procedure should do one specific job. Use of a procedure as a building block for more complex procedures is easier if extra commands are excluded. For instance, FLOWER should contain only the instructions for making the flower. If commands that move the turtle into place or set pen colors are not included, FLOWER can be easily reused elsewhere.

3. Simple, easy-to-read commands make it easier for children to debug procedures. Use REPEAT and subprocedures such as SQUARE whenever possible. Encourage the children to look for the shortest and most easy-to-understand way to write. For example, when placing the turtle, they may find SETPOS [50 50] or SETHEADING 100 FD 70 preferable to something such as RT 90 FD 50 LT 90 FD 50.

Off-computer preparation for procedure writing allows students to work more efficiently at the computer. While some children prefer to explore directly on the computer, and some like to manipulate objects, many students like to use pencil and paper and first draw a rough sketch of their picture on quarter-inch graph paper. The squares approximate 10 turtle steps. By counting the squares, students can more easily estimate approximate distances on the screen when they are at the computer. The turtle twirler (see September LX, page 16) can help determine directions and angles.

Students may also make an "outline" of their superprocedure and subprocedures. For instance, if making an airplane, the superprocedure may be called JET with subprocedures of BODY, WINDOW, RWING, LWING, TAIL, and EMBLEMS. A quick conference to check these plans before a student gets on the computer can save hours of debugging.

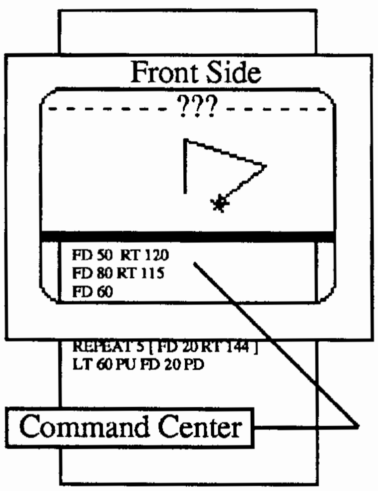
If the wait to use the computer is very long, many of these procedures can be tentatively written out on paper. At the computer, the procedures can be entered, tested, and debugged. Once children are aware that plans can be made off the computer, you may see notebooks full of ideas waiting to be tried when they next "boot up."

Children will soon discover there is no need to recreate previous work if it was saved as a procedure. Periodically saving work also reduces the risk of losing it through power outages, accidental erasure, or crashes. As awareness grows of these advantages, children choose procedure writing as the easy way to do a Logo project.

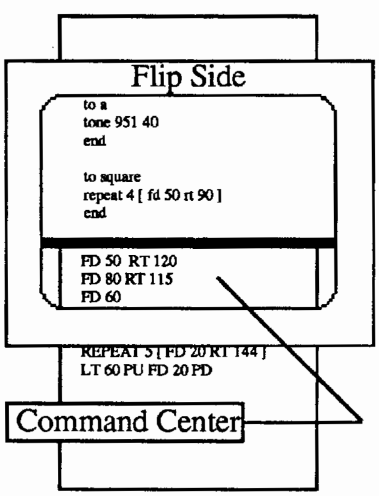
The product isn't as important as the process of problem solving. It's helpful for the teacher to review the process with students and to point out how techniques can be transferred from one problem to another. Such transference doesn't happen automatically. There are many ways to solve a problem depending on individual style and approach. Encourage students to recognize and share varying viewpoints for problem solving to build understanding of their own experience. This may help to increase the repertoire of thinking skills as well.

Make the Computer Do the Work

Students can use the computer to make their work easier. With LogoWriter, for example, commands can be repeated without retyping. Put the cursor on a line already typed and press RETURN. The turtle follows the same commands again! All of the commands typed since the program was booted are still there to be reused. Move the cursor with the "up" arrow so that the lines scroll down. It's easy to revise a line using <Delete> and inserting new elements.



To help younger children understand how they can recycle instructions, construct a monitor screen from paper or cardboard. Show the "front side" and "flip side" with a window below each to represent the command center. Write the command lines on a separate piece of paper to sandwich between front and flip sides. Pull it up and down in the command window, demonstrating that the commands disappear, yet are still available to use.



These techniques can also be used with Commodore Logo on those commands still visible on the text screen. Apple versions allow for the repetition of the last line (Ctrl Y in Apple Logo, Ctrl R in Apple Logo II, and Ctrl P in Terrapin) and revisions of the line before pressing RETURN.

The SELECT, COPY, and PASTE functions are helpful for writing procedures in LogoWriter. Explore a Logo idea in the direct mode. When it works satisfactorily, type (APPLE KEY) 1 to use the SELECT mode. Highlight the command line that will become the body of the procedure. Next, type (APPLE KEY) 3 to COPY the line into the clipboard. Go to the flip side of the page and type (APPLE KEY) 4 and the line that was copied is not PASTEd on the edit screen. Type TO and the name of the procedure, END at the end, and you've taught the computer to do something new.

The computer can be used to calculate directly or within a command. To find the number of degrees needed to draw a polygon with 13 sides, type SHOW 360/13 and the answer will appear: 27.6923. Another way to do this is to type REPEAT 13 [FD 20 RT 360/13]. The calculation will be done and the figure will be drawn at the same time.

We hope that these ideas will be of value as you help your students explore the power of Logo procedures.

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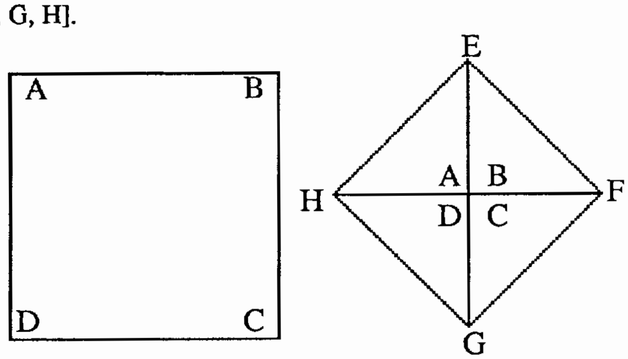
Logo LinX

by Judi Harris

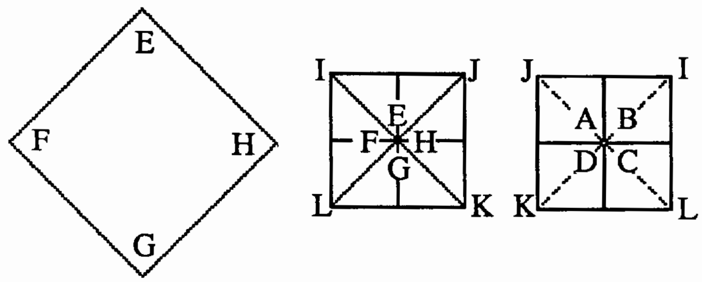
Paper, Process, and Polyhedra: When the Product Isn't a Picture

Did you ever catch a "culprit" with a folded paper "fortune teller" in your classroom? They are constructed (often when you are not looking) something like this:

Start with a square piece of paper, and fold the corners [A, B, C, D] to the center. This produces four more corners [E, F, G, H].



Turn the paper over, and fold the four corners [E, F, G, H] to the center, producing additional corners [I, J, K, L]. Turn the paper back over.



To make the paper figure, push the corners [I, J, K, L] down, while opening up the corners [A, B, C, D]. Once constructed, different sections of the object are labeled with colors, names, numbers, and fortunes. The construction is then consulted (during recess time, you hope) in ritualized counting and question sequences, to reveal the future (or the secret admirers) of the answer-seeker. Traditionally, this folk craft is called "origami," and this particular object is the "salt cellar" or "pig's foot," but to many children, it is simply "awesome."

Add to this popular pastime the paper airplane and the inflatable folded paper box (which can be popped, if you dare, at just the right unsupervised moment,) and you have the basis for disciplinary action -- or a fascinating investigation into the properties of polyhedra, and the transformation of two-dimensional drawings into three-dimensional shapes.

More on the Medium

Does the medium determine the means? The method? The end? Fortunately, it doesn't have to. Logo need not be confined to exploration in two dimensions. In fact, the pictures that students create with Logo don't have to be the end-point in their investigations; they can be the planning models of later, off-computer construction.

Tests of spatial ability often include paper and pencil tasks which require the test taker to look at a drawing of a three-dimensional object, then choose the appropriate corresponding "unfolded" view. Since so much of required school work is two-dimensional, it is little wonder why these types of activities (presented, of course, in two dimensions) are difficult for children, while the construction of paper airplanes is not. Logo can help to link the dimensions experientially, if it is used as an architectural tool, or model-maker.

I recently worked with a sixth grade class that was immersed in a schoolwide interdisciplinary study called "Shapes, Patterns, and Structures," the brainchild of a most talented science coordinator, Mrs. NancyLee Bergey. These otherwise sophisticated youngsters seemed to have trouble with every kindergartener's favorite activity: building. Since polyhedral constructions are the bases of many organic and inorganic structures (from sub-atomic to macro levels), we planned a sequence of geometric investigations that we hoped would provide the needed hands-on experience with three-dimensional building, at a level that would be cognitively sophisticated, tactily dependent and, of course, fun.

The Third Dimension

"But my II+'s won't run ExperLogo! How can we work in 3-d at my school?"

All the peripherals you need, really, are a printer and a polyhedra primer. The challenge to the class seemed simple.

"Use Logo to draw any three-dimensional figure, unfolded, in separate or connected pieces. You may use the wooden polyhedra models for inspiration, or you may design your own 3-d shapes. Then print your paper model, cut it out, and construct the shape with tape or glue. If the 3-d object needs adjustment, revise your Logo procedures and repeat the construction until it meets with your approval."

It was fascinating to watch the students cooperatively plan, draw, and dispute such attributes as relative side length, surface area, number of vertices -even volume. They hauled out the scrap paper, calculators, seldom-touched origami kits and paper-folding books to tackle this peculiar challenge. They constructed leaning pentahedra, tetrahedra with uncooperative edges, and partially-crushed cubes (hexahedra,) but also nearly perfect rhombicuboctahedra, truncated octahedra, and hexakaidecahedra, piece by piece.

Soon, the computer center and their classroom were decorated with polyhedra in all shapes, sizes, and stages of construction. The students first used *Polyhedra Primer* (Pearce & Pearce, Dale Seymour Publications, 1978) to identify the objects that they had already designed and assembled, then later as a source of more complicated three-dimensional construction challenges. The multisyllabic names caused many giggles, but also an interest in the relationships between individual syllable meanings and the geometric components of the constructions. Fortunately, the book shows the polyhedra in 3-d form, so that it was a source of inspirations, not solutions.

Logo as Model Maker

All of this activity was framed as a "planning stage" to the students. The next step in the project was to use the model(s) of their choice to help them to reconstruct similar polyhedra with balsa wood and glue or plastic straws with pins or string.

They then were able to manipulate the same edges and vertices of the constructions in three dimensions that they had just commanded the turtle to draw in two dimensions. This new perspective seemed to help them to focus on vertices as meeting-places of angles, which, in 3-d, didn't necessarily sum to the "total turtle trip" that they knew so well. It also seemed to create a heightened awareness of surface area and volume, as many of the groups decided to add tissue paper sides to their plastic straw polyhedra. Mrs. Bergey suggested that they test the strength of their constructions, and the generalizations that they derived about the relationships of structure to stability made the physicist in her proud.

When the End Is the Means

As usual, this adventure was quite instructive for me, too. So many of the turtle graphics projects that I suggested to my students had placed the picture as the final product; that structure had become almost implicit. How refreshing, then, to see the children using the Logo environment as an architectural tool, and a bridge between problem solving in two different physical realms!

Perhaps we need to devote as much thought and energy to the variety of means by which we suggest children solve problems as to the types of problems themselves. Logo itself certainly doesn't dictate a finite set of "appropriate" applications or exploratory methods. It is my hope that the projects described in this column each month have helped, and will continue to help you and your students expand and elaborate upon different methods and topics to investigate through Logo.

Since much of two- and three-dimensional geometry is credited to the ancient Greeks, I'll close with a bit of advice from one of their greatest teachers:

Do not then train [children] to learning by force and harshness; but direct them to it by what amuses their minds, so that you may be better able to discover with accuracy the peculiar bent of the genius of each.

--Plato

Judi Harris was an elementary school computer use facilitator, graduate education instructor, and computer consultant for a number of public and private schools in Pennsylvania. She is now a doctoral student in education at the University of Virginia. Her CompuServe number is 75116,1207.

MathWorlds

edited by A. J. (Sandy) Dawson

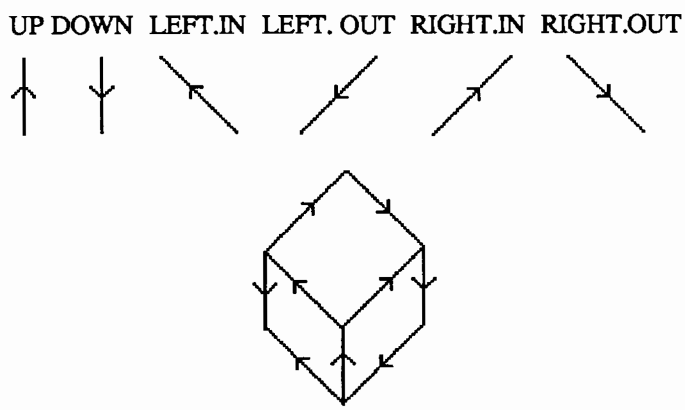
What Makes a Good Intervention?

The subtitle for this month's column is taken from a paper Liddy Nevile presented at the Second International Conference for Logo and Mathematics Education held this past July in London. Of course, there is not a single answer to Liddy's question. The three illustrations below, however, do provide some "fresh" replies to the question, and in so doing give a few suggestions of how to extend Logo to secondary and college level students.

Isometric Intervention

For the past few years, Liddy Nevile and her colleague, Colin Fox, have been exploring what they call "real microworlds for learning as opposed to those which merely enable users to do neat things." [3, p.201] They have worked at creating convenient and easily accessible means for Australian teachers to use Logo in new ways. They were concerned with creating Logo experiences which would assist students in acquiring an intuitive grasp of mathematical constructions.

Though mathematical constructions may seem trivial to some, large numbers of students seem unable to visualize and draw mathematical figures, thereby limiting their pursuit of mathematics. In response to this, Nevile and Fox designed a microworld for isometric drawing. "Operating it is simple, as there are, at first, six basic actions which generate the shapes." [3, p. 205]



In addition to helping students gain insight into three dimensional objects, Nevile hopes that the use by teachers of such microworlds in the secondary school "... which relate to topics... traditionally difficult to teach, these teachers might feel there will be legitimacy in using Logo for this purpose, and that... they will thus be initiated into Logo." [3, p.207] I hope so too.

Cycloidal Representations

A different kind of intervention was created by Uri Leron and Uzi Armon. They used an experience which many Israeli elementary school children have and transformed it for exploration by secondary and tertiary students. Children in elementary school use trundle wheels to measure distances. While doing this, if they watch carefully the path traced by the mark on the wheel, they would "see" a cycloid.

The question Leron and Armon focused on was "what path is traced by a point fixed on the circumference of a rolling circle?" The title of their paper at the Logo and Mathematics Education conference was, "How to Explain a Cycloid to a Turtle?"[1]

In addition to answering the question, Leron and Armon commented on the issue of local and intrinsic representations versus more standard global and extrinsic representations. Their main point in this regard is that they "...wish to study various representations and the relationships between them, rather than pledging allegiance to one. Understanding is best when we are at home with several representations and can choose at will the one which best suits the situation at hand.

"Of particular interest are methods of moving between standard and turtle representations. Using the powerful