Time For A Challenge

Judi Harris

College of William and Mary

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Logo LinX
by Judi Harris
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Rich problems make the best Logo projects. Think, for example, of "Logo Poetry," tessellations, "Pig Latin," and fractals. All are, at first glance, good Logo challenges. But as your students (and you!) write Logo procedures that translate their patterns into computer activities, ideas for related projects spring to mind. And as you work on those new challenges, "idea reproduction" continues. Investigation into these broad areas of interdisciplinary, intrinsically fascinating inquiry reveal what Papert called powerful ideas. The subject's inherent patterns provide the pliable mess of material; Logo's structure encourages "messing around" in search of patterns and structure.

The Catalyst

Patricia Davidson first introduced me to the notion of "rich problems" at a National Council of Teachers of Mathematics conference. Ms. Davidson is best known for her resource books of mathematical learning activities that incorporate the use of manipulative materials. She also has done extensive research work on computational learning styles. At the conference, she spoke of mathematically rich learning situations with no intentional reference to Logo applications. I would hasten to add that there are rich problems that can be investigated in all subject areas, and that those with definable patterns make for the most engrossing inquiry when using Logo as an investigatory tool.

Davidson suggested one particularly rich store of problems that dealt with digital time patterns. Few of us will forget the pride and excitement we felt when we received our first wristwatch. (I'd even wager that yours is still in a box somewhere, preserved for posterity.) Now that digital watches are often less expensive to buy than analog timepieces (watches with hands), many children use them daily.

Some of the children that I taught had digital watches that could display so-called "military time," or time based upon a 24-hour clock. Alternate methods of telling time fascinated them, and the educational implications of the options intrigued me. When Ms. Davidson suggested digital time as a good source of rich problems, I "oooo-ed" along with the rest of the audience. The idea had all of the ingredients necessary for a good project: interest, innovation, relevance, multiple levels, powerful ideas, unanswered questions, and many "right answers."

The "Mess"

Intuitively, we recognize when we stumble upon a rich problem. Groups of related sub-challenges quickly suggest themselves, crossing disciplinary and methodological boundaries, and making apparent new connections. I wondered, for example:

1. What are the frequencies of digit occurrence in each hour of digital time (how many 0's, 1's, 2's, etc. appear)?
2. How many times in a day are palindromic (able to be read forwards or backwards, such as 12:21)?
3. If we assume that the colon (:) in-between the hours and minutes is an equals sign (=), and that there are mathematical operators (+, -, X, /) in-between the hours and minutes digits, how many times could be computationally correct in a day (i.e., 7:43 could mean 7=4*3, 8:24 could mean 8=2*4)?
4. Does the choice of a digital or analog watch change the wearer's conception of time? If so, how?
5. How did the advent of standardized time change history?
6. What might happen if we asked someone to live for a period of time without a clock for reference?
7. What common expressions and famous sayings mention time and time-keeping? Are there general themes that run through these quotations?
8. How do quartz crystal, liquid crystal, and spring mechanisms work?

Perhaps these ideas have inspired some additional thoughts to add to your list. If so, or if you "oooo-ed" earlier in the article, then this is a rich problem for you, too.

Messing Around

I find it quite interesting that I originally began by suggesting investigation of some of these sub-problems by more traditional means: paper, pencil, and calculator. The students pointed out that, once they recognized the patterns of a particular piece of "the mess," there really was no point in completing the computations repeatedly for all examples of the pattern. I agreed, but added that the computations must all be executed, in any case, to be able to fully generalize the pattern.

Has your "Logo light bulb" brightened up? "Why not direct the computer to do the tedious computations, then let us find the patterns?" as my students impatiently suggested?

Sub-problems, of course, turned out to be conglomerations of challenges. It seemed logical first to write a set of procedures that simulate the functioning of a digital clock. Here is one solution:

```
TO DIGITAL.CLOCK :HOURS :MINUTES
IF :HOURS > 12 [ MAKE "HOURS 1"]
IF :MINUTES > 59 [ STOP ]
PRINT.TIME
DIGITAL.CLOCK :HOURS :MINUTES + 1
MAKE "MINUTES 0"
DIGITAL.CLOCK :HOURS + 1 :MINUTES
END

TO PRINT.TIME
CLEARTEXT
SETCURSOR [12 19]
TYPE (WORD :HOURS ":" :MINUTES )
END
```
(Note: To use these procedures with Terrapin, Krell, or Commodore Logo, eliminate all brackets, change SETCURSOR to CURSOR, and TYPE to PRINTL.)

Notice that there are two recursive calls in the DIGITAL.CLOCK procedure. This is logical, since for every one time that the value of :HOUR is increased by one (in the second recursive command,) the value of :MINUTES has to have been increased by one (in the first recursive call) 60 times.

Messy Temptations

Now it's your turn. How might you amend and append this fundamental idea to get the computer to:

--count digit frequencies as it displays the times?
--graph these frequencies? (See: Glen Bull and Paula Cochran's "Teaching Tools," Sept. '86 LX, pages 10-13.)
--display, count and graph the frequencies of all times displayed between two particular starting and ending times?

If you'd like to see a listing of procedures I've developed to solve this particular set of sub-problems, please send a long, self-addressed, stamped envelope to:

Judi Harris
292 Ruffner Hall
Department of Educational Studies
University of Virginia
405 Emmet Street
Charlottesville, VA 22903

But, please! First give yourself time for the challenge.

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 electronic mail address is 75116,1207.

Logo Conference Information

March 14, 1987. Beyond Computer Literacy - Preparing for the Next Generation, sponsored by the Network for Action in Micro Computer Education (NAME), Computer Learners Users Educators, the NJ State Department of Education, New Jersey School Boards Association, and the Ridgewood NJ Public schools. The keynote speakers for the conference are Dan and Molly Watt. The conference is being held at Ridgewood High School, Ridgewood, NJ. For more information, contact: Gary S. Stager, NAME, Fallon Education Center, 51 Clifford Drive, Wayne, NJ 07470, or call (201) 694-7800.

MathWorlds

edited by
A. J. (Sandy) Dawson

This month I have the pleasure of welcoming Jim King as a guest columnist. Jim is a professor of mathematics at Washington University in Seattle. He teaches, among other things, a senior level geometry course required by all students studying for a mathematics degree in secondary education. In the past few years, Jim has incorporated Logo into his course. One of the sections of the course deals with three-dimensional Turtle geometry. The column which follows is a condensed version of a much longer piece Jim wrote about this unique Turtle which can draw shadows. Now, for an introduction to a new, shadowy microworld, read on and explore the realm of the Affine Turtle.

The Affine Turtle:
A Turtle That Can Draw Shadows
by James King

When the sun shines on squares and circles standing upright on a flat surface, they cast shadows which are parallelograms and ellipses. Other 2-dimensional figures, such as trees, cast shadows with lengths and angles distorted. This same sort of distortion occurs when we represent a figure drawn on a sheet of paper as it is seen from an oblique angle (from a distance). Both are examples of parallel projection.

One way to draw such shadow figures in Logo is to use a 3-dimensional turtle to mimic the 3-dimensional sunlit scene. However, it is easier to draw them using the two-dimensional turtle described below. It should not be surprising that this is possible; after all, architects create such renderings on two-dimensional drafting tables. The mathematics of such figures is in fact a part of plane geometry, a part called Affine Geometry.

Using the Affine Turtle Commands

First we will describe how to create figures with the Affine Turtle. The basic commands for the Affine Turtle correspond to the usual turtle commands but begin with an A; namely, AFD, ABK, ART, and ALT are used in place of FD,