ISSN 0734-1717

The National LOGO Exchange

Volume 1 Number 2 FORWARD 100! October 1982

Turtle Geometry

Don't Wait for the Movie

There are those who regard turtle graphics as little more than "kid stuff," with appeal limited only to elementary school children, and potential limited to mastering a few simple turtle commmands.

People in the above category are not to be "put down" for their gross ignorance. They simply have not yet had the opportunity to read "Turtle Geometry," a textbook by Harold Abelson and Andrea diSessa. That this book is one of substance is indicated in the forward: it is but one volume in the MIT Press Series in Artificial Intelligence.

The next clue comes from the table of contents. It starts off easily enough with turtle graphics and a treatment of the familiar POLY procedure. The reader is then led into looping (closed curve) programs, and is introduced to the powerful idea of feedback. Building upon this, Abelson and diSessa take up the processes of growth and recursion.

So far, so good. But next, the "heavy part" begins. And if you are still thinking at the 3rd grade level at this point, try this list of topics for size!

Here come vector analysis, turtle state, three-dimensional turtle space, rotations, projections, topology, deformations, turtle spherical geometry, curvature, turtle on a cube (!), piecewise flat surfaces, Euler characteristics, curved spacetime and (are you ready for this?) Einstein's Theory of General Relativity!

It is beginning to sound like a college geometry or physics course, and we haven't even made it to the first chapter! But there is no reason to be apprehensive.

In spite of the depth of the subject matter, the authors have described the ideas and examples so clearly that a person with no more than an "average" college education is able to follow and understand.

continued on page 6

A Parent Looks at LOGO

by

Sandy Towberman

Having observed my nine-year-old working with the LOGO turtle, I am convinced that LOGO is a way to create something close to the ideal learning situation, provided that the teachers take advantage of its benefits.

I would like to share my observations with you. Often, it seems, when it comes time to make a decision about innovative ideas in education (and LOGO is most certainly one!), parents are rarely consulted. Or, perhaps worse, their response may be assumed. I want you to know how I feel about LOGO for my child.

I still have much to learn about LOGO. But, as a parent, I can immediately identify three areas with major educational benefits for children.

EXPLORATION

One of the keys to optimum learning is the student proceeding at a self-paced rate, learning something thoroughly before moving on to something else.

I feel that LOGO meets and beats this criterion: it harnesses a child's natural curiosity, allowing him to explore new frontiers. It enables him to discover basic principles by making his own mistakes and leaning from them (a skill of living). He can repeat things as often as necessary to "double-check."

Through working with LOGO, a child learns to integrate one principle with another, not merely learning the principles, but the implications of each one and when to apply it. Such "experimental learning" is invaluable.

A related by-product is that a child can develop a keen understanding of research, and of the scientific method of studying cause and effect by changing only one variable while keeping all others constant.

continued on page 2

The National LOGO Exchange, copyright 1982 Posy Publications, a part of The Posy Collection, all rights reserved. Published monthly September through May, $25 per year, $45 for two years, mailed FIRST CLASS from Charlottesville, VA. Add $5 per year for addresses outside the United States. Single copy price $3. Opinions expressed by the authors are not necessarily those of The National LOGO Exchange. Address all editorial correspondence to the editor at The National LOGO Exchange, Post Office Box 5341, Charlottesville, VA 22905. ISSN 0734-1717

Editor......................Tom Lough

Walls, Fences, and Camps

We see walls of every fashion built everywhere we look. Walls to keep things in, walls to keep things out. Physical walls, mental walls, social walls, emotional walls. And, we must add, professional walls.

When an educator, having become familiar with a certain aspect of the profession, becomes entrenched in a sort of "comfort zone," and refuses to consider alternatives or improvements, often walls are built to block change. Akin to the QWERTY phenomenon of Papert, the situation often leads to camps of stagnation and lethargy.

For a pointed example, consider the following scenario. A group of educators have discovered LOGO and are genuinely excited about its potential. Another group in the same school, having had experience with BASIC, forms a lobbying camp to persuade the administrators that LOGO is "not as good as BASIC."

Committees are formed to "study" the situation. Actions bog down. The communications between the camps take on a chilling hardness. The LOGO introduction never takes place.

What happens? The children are deprived of the most exciting educational opportunity now available. The educators are split by walls and fences into opposing camps. Both friendships and professional relations suffer.

This need not happen, if the situation is approached with a genuine desire to understand "the other side" and the underlying feelings which cause them to act as they do.

A tall order, true. But, the children ... the children ... ▷

Parent continued

CREATION

Another key to optimum learning is <u>self-confidence</u>. A student must believe in himself to function at peak capacity.

Again, I feel that LOGO surpasses the criterion. With the fresh approach of the child being the teacher and the computer waiting to learn, the child's self-confidence is raised because <u>he</u> is in control. He dreams up the project and instructs the computer what to do, where and how to do it.

So, as a child learns the basic principles through experience and how to apply them, he finds that he can make reasonably accurate predictions. This boosts his courage and confidence. The computer's speed offers immediate feedback regarding the accuracy of his predictions, making it easy to correct errors.

These two things make it possible to gain quickly much actual "experience" in a non-judgemental atmosphere, again boosting self-confidence.

As a valuable by-product, a child can develop the ability to express himself creatively, and to believe that his ideas count!

MOTIVATION

An additional key to optimum learning is a <u>sense of purpose</u>. This keeps the interest level high.

Again, LOGO excels. Today's child, receiving much visual stimulation, is receptive to this medium. But LOGO is more than entertainment. It captures the child's interest because it is <u>his</u> project and <u>he</u> is in control.

A certain need arises because of one of <u>his</u> goals, and <u>he</u> must either create a tool to use, or plan how to accomplish a certain task.

An excellent by-product is that the child learns to apply his knowledge to the world around him. He will be able to see the geometric shapes in even complex forms, and he will be able to estimate with reasonable accuracy the size of an angle and the relative length of a line. (Is not this a skill with which an artist captures a likeness?)

It seems to me as a parent, then, that LOGO offers major benefits relative to an optimum learning situation through exploration, creation,
continued on page 4

TIPPS for TEACHERS

by

Steve Tipps

Patterns and Repetition

The LOGO command REPEAT marks an important transition from control of the turtle on the screen to programming. Programming is the ability to conceive and follow actions which are not individually and immediately performed as are the FORWARD, BACK, RIGHT, and LEFT commands which allow the student to control the turtle's movements.

However, understanding REPEAT and using REPEAT demands recognition of patterns and how useful those patterns can be in describing the world.

BEGINNING PATTERNS

When objects or events are arranged in some repeating sequence, a pattern is formed. Children's understanding of the world according to Piaget moves from body to object to symbol. Patterns with which they work can also follow that developmental sequence. The children can stand in a line in some pattern such as:

BOY GIRL BOY GIRL BOY GIRL BOY ...

or, a little harder:

GIRL BOY GIRL BOY GIRL BOY GIRL ...

or, with chairs:

SIT STAND SIT STAND SIT STAND ...

or, in pattern by color of clothes:

BLUE RED GREEN BLUE RED GREEN ...

The variety of patterns which children can act out and the possible complexity of the patterns are almost infinite. Rhythmic patterns are another example at the body level:

CLAP CLAP (rest) CLAP CLAP (rest) ...

CLAP STOMP STOMP CLAP STOMP STOMP ...

or, with instruments being played:

BANG TING RASP BANG TING RASP ...

or, with animal sounds:

MOO WHINNY OINK WHINNY MOO WHINNY ...

The role of the teacher in pattern games is crucial. While the teacher may set up some of the patterns to alert the children to their existence, very quickly the children should be working in committees to invent their own patterns to challenge their classmates.

The examples chosen reflect a belief that active, body oriented learning is an important precursor to later symbol manipulation. Mary Barrata-Lorton's Mathematics Their Way (Addison Wesley, 1978) has an excellent chapter on patterns as does a booklet in the Nuffield Mathematics series. The examples which are found should only stimulate other exercises for the teachers and students to invent.

WHAT TO LEARN FROM BEGINNING PATTERNS

If you had to stop for a split-second and ponder any of the patterns above, you are alreay experiencing the learning which should be going on with patterns. Recognition that a pattern exists is an important skill. However, counter examples of random placement can also be used to point out that there is not always a pattern to things.

Exposure to patterns which vary in length, number of items, and complexity of items broadens the experience beyond simple AB AB patterns. Many commercial materials include only 2- or 3-item patterns or only present one "kernel," such as AB. Both practices simplify the pattern concept too much.

Children should be able to show where a pattern begins and ends (first and last elements), tell how many elements are in the pattern, describe how many repetitions are in the example, and add another repetition or fill in missing elements. Children should be able to create their own patterns and follow the sequence of other children's patterns.

The skills which are started with beginning patterns continue with object and symbol patterns.

OBJECT AND SYMBOL PATTERNS

Art materials are an obvious way to continue children's exploration of patterns. Circles, squares, triangles, and other shapes of many colors can be glued on strips of manila paper or sentence strips.

The obvious can be much more complicated than is first apparent. Patterns which focus on attributes

Tipps for Teachers continued

rather than labels and patterns which require analysis of more than one physical attribute will challenge students in the fourth or fifth grade.

For example, the pattern of the sequence RED SQUARE, BLUE CIRCLE, GREEN SQUARE, RED CIRCLE, BLUE SQUARE, GREEN CIRCLE requires analysis of two different subpatterns within a main pattern. Or, a pattern might focus on the number of sides and angles of irregular shapes rather than easy-to-recognize squares or octagons.

Multiple classification games with pattern blocks, beads, buttons, seeds, etc. are related thinking activities which encourage children to think abut two variables at the same time. Geoboards and pegboards can also be used for pattern creation.

When students are encouraged to look for patterns -- regularities in the world , they will become aware of many examples: architectural details on buildings, wallpaper and fabric, automobile design, shapes in paintings and sculpture, how supermarkets are arranged, letters in words (CVC), TV schedules, ad infinitum.

However, you may be wondering what all this has to do with LOGO. Recall that LOGO is another tool which helps the teacher create an environment for thinking.

Isolating LOGO from the rest of the goals of education and other curriculum areas would be foolish. Preparing children to understand the concepts imbedded in LOGO is essential. Patterns are an important thinking strategy which is related to the LOGO command REPEAT.

REPEAT, REPEAT, REPEAT

When children have full control of the turtle with the distance and direction commands, they will usually begin to set up a pattern of commands such as:

```
FORWARD 50
RIGHT 50
FORWARD 50
RIGHT 50
FORWARD 50
RIGHT 50
etc.
```

When the teacher observes that several children are using patterns to create figures and designs, the time has come to introduce the REPEAT command. The teacher might ask if there is a pattern to the series of commands. The teacher who has prepared students with patterns could suggest that a bracket be put around the kernel of the pattern, as:

```
[ FORWARD 50 RIGHT 50 ]
```

The question of how many repeats comes next. The child may say 12. Then the teacher could suggest

```
REPEAT 12 [ FORWARD 50 RIGHT 50 ]
```

Quickly, the student will recognize that the REPEAT statement saves a lot of effort and will get quicker results with the turtle.

Introducing LOGO commands in response to the needs of the children is very different from having a lesson on REPEAT. Glen Bull's Microworlds column in this issue gives greater meaning to this statement.

Good programmers constantly look for ways to take advantage of the ability of the computer to do the same action over and over and over very rapidly. Repetition is a prime programming concept which occurs in different ways. The REPEAT statement is only the first example of this powerful feature of LOGO. But using any of the repetitive ability of the computer is based on patterns. The next column will suggest some of the things which children can do with REPEAT before going further with LOGO. ▷

Steve Tipps is a professor at the University of Virginia, and conducts LOGO workshops for teachers throughout the eastern United States.

Parent continued

and motivation, provided that you, as teachers, catch the vision that computers are more than merely an expensive set of electronic flash cards. Parents are counting on you for this!

This is the unique challenge LOGO places before us. Explore! Create! Motivate! ▷

Sandy Towberman is an artist, writer, and musician who, with her husband, a Lutheran clergyman, is raising a daughter in Canton, Ohio.

In LOGO, as in life, the direction you are heading is often much more important than how far you go.

MICROWORLDS

by

Glen Bull

The Meaning of Meaning

Throughout formal academic training it is frequently necessary to master information which has a deferred application. In some instances the application may come relatively soon, as in the case of calculus in engineering school. In other cases the information may not be employed for years.

There is almost always a presumption that the subject learned will be of value at some time, whether immediate or deferred. Only a perverse instructor would claim to teach meaningless materials, and the phrase "meaningless learning" would appear to be almost a contradiction in terms.

Therefore, I was mildly surprised to find that in some studies children appeared to learn to read faster through a non-meaningful approach.

Two senses in which the word "meaningful" can be used may resolve the apparent contradiction of children learning to read more effectively by using a less meaningful approach:

(1) comprehensible, and
(2) of personal interest.

In the study on reading, the term probably refers to the first sense of the word. In this sense, meaningful vs. non-meaningful might be translated as delayed vs. immediate comprehension. However, differences resulting from delayed vs. immediate comprehension in reading acquisition might ultimately prove to be minor in comparison with the factor of the interest of the learner.

WRITING POWER

Both reading and writing are language skills which are acquired with great difficulty in comparison with the relatively painless acquisition of oral language. A typical child in the fifth grade completes an essay on "What I Did on My Summer Vacation" under duress. It's certainly nothing that would have occurred to him to do on his own.

continued

Written language ultimately becomes comprehensible to most children, but for many it never becomes meaningful in the second sense of the word. The problem is that written language simply isn't powerful enough at the time it is learned. Power in this context may be defined as allowing a person to do something they want to do without undue difficulty.

Written language may not be a powerful tool for a child if it does not allow him to accomplish a personal goal. With this perspective, it becomes clear that the struggle to teach a child to read may resemble a boy scout dragging a little old lady across the street. It is considerably easier to do if that is where she wants to go!

This is regrettable, but generations of teachers have long consigned themselves to the fact that much which is learned is only appreciated in retrospect.

It is apparent that few fifth graders will ever find an essay the most effective way to transmit information to their teacher. The paper is buried among thirty others, and the chances are that the teacher has seen similar efforts from classes in preceding years.

Further, the teacher doesn't write back, at least not in length. The most that can be expected is a cryptic word or two on the side. Under those circumstances, it's small wonder that most children don't find written language a very satisfying avenue of communication until later in life.

COMPUTER POWER

This raises the question of whether communication with a computer might be more satisfactory for a child. A computer, after all, isn't even human. However, it can respond.

The element lacking in written communications to teachers is that of turn-taking. There simply are not enough hours in the day for a teacher to respond to each child with a missive of equal length. Even if there were, it is doubtful whether a classroom instructor could find something fresh and interesting to say to each child.

In contrast, communication with an interactive computer system is turn-taking personified. The child commands the computer, and lets the computer know that it is its turn by pressing "return." The computer then responds to the best of its ability, and informs the child of its turn by returning a prompt.

continued on page 6

Microworlds continued

Further, the child is the one who controls the direction of the conversation. This means that a conversation with a computer need only occur if the topic is of interest to a child.

Is this type of activity meaningful? It certainly can be if meaningful is defined as "of personal interest." The programming skills learned in the process also will be of value to both the learner and society at a later date.

LOGO POWER

All of the above is true only if the child can use the computer to accomplish a personal goal. LOGO is particularly suited to use by both adults and children because it allows a great many activities to be accomplished with less fuss than other computer languages --- in short, because it is more powerful in many more applications.

This applies only if LOGO allows the child to accomplish a desired activity. It should be expected that some children will not want to draw squares, triangles, landscapes, or any of the other possibilities offered by LOGO's graphics capabilities.

It may be that some of these children will be engaged by the list-processing and the language-handling capabilities inherent in LOGO. However, there will be a residue of children who do not see the point of LOGO, and who will not want to do anything which LOGO allows them to accomplish.

For these children, LOGO is meaningless, at least in the sense of being of personal interest. Their avenues of interest will lie in other directions.

I believe the number of these children will be small, but a certain number is inevitable. The adult who forces a child to perform sterile exercises with LOGO in the face of this lack of meaning does not understand the meaning of LOGO. ▷

Glen Bull is a professor at the University of Virginia, and teaches LOGO courses at both the graduate and undergraduate level.

Mindstorms: Special Notice!

Seymour Papert's "Mindstorms" is now available in paperback from Basic Books, 10 East 53rd Street, New York, NY 10022, for $6.95.

Turtle Geometry continued

The first page of the text greets you with the announcement that turtle geometry is a mathematics designed for exploration. For those already acquainted with LOGO philosophies, this idea will be refreshingly familiar. This design is carried out to the fullest in the organization of the text.

Numerous examples and problems, both closed and open-ended (those are especially fun!), are sprinkled throughout. Moreover, they are grouped into levels of difficulty. "Regular" problems have no special designation. More difficult ones are marked with (D). The most difficult (impossible?) ones appear with (DD).

Even then, the authors displayed a sense of sympathy and support for their readers by adding a section of hints and another of more complete answers at the back of the book. This was done in a way designed to provide a gentle encouragement to those who took up the challenges.

The reader is cautioned not to <u>read</u> the book, but to <u>do</u> it! With so many opportunities for exploration provided, it seems unlikely that any reader could resist the invitation to participate. So, if I may offer a bit of advice, make sure you have access to a computer with turtle graphics (LOGO would be best) before you begin your trip through the incredible world of "Turtle Geometry."

The publication was designed to be a textbook at the advanced high school or college undergraduate level. But it is much more than that. The authors have incorporated ideas and concepts from many diverse sources and have interwoven them into a tapestry whose intricacy is not evident to a casual observer.

It would not be unreasonable to predict that this or similar texts will be used to teach the physics and mathematics courses of the future, with emphasis on exploration and doing, instead of passive learning. The dream of an information system containing laws of physics, theorems of mathematics, and rules of behavior which can be interrogated by students in their own way at their own speed comes one step closer to reality.

"Turtle Geometry," by Harold Abelson and Andrea diSessa, 1981, The MIT Press, Cambridge, MA.

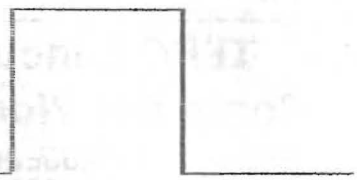
FORWARD 100! ▷

Fractal Fun with LOGO

Fractals are an interesting class of geometric objects. They can be studied and manipulated by first graders, and used by research physicists to explain extremely complex natural phenomena.

But the best thing about fractals is that LOGO can be used to draw them easily. Thus, the study and manipulation of fractals is within the reach of virtually everyone.

Let's take a look at a sample fractal to make sure we all know what we are talking about. Consider the shape below.

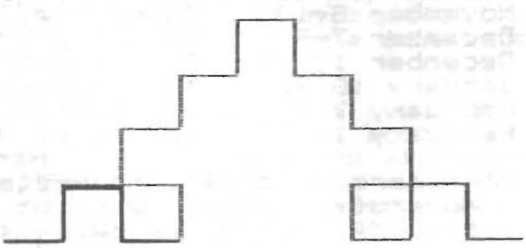


This is a rather simple line drawing. But it has an interesting property. It can be drawn upon its own segments! Look again. Can you visualize a figure with the same shape but with one-third the size being drawn along each straight line segment of the form shown above?

Such a pattern has an appeal to young children equipped with only a ruler, pencil, and paper. Refinements are easily constructed, until the first practical limits imposed by infinity are encountered.

Thus, fractals could be used as an extension of the ideas for learning about patterns presented in the Tipps for Teachers column in this issue.

Here is a drawing of the shape with one "repetition" of its pattern drawn instead of its original segments. Trace the outline carefully to find each of the five smaller figures superimposed upon the original.



continued

Can you visualize the form of the next "repetition" from the pattern above? If so, you have thus encountered the concept of a space filling curve. As the depth of the repetitions increases, the total length of the line of the figure increases, presumably without limit. And, the line fills more and more of a space with a particular shape.

It is an instructive exercise to attempt to write a graphics program in BASIC to draw this shape to an arbitrary depth of repetitions. In a very short time, the limitations of that language become evident.

However, it is possible to write a LOGO program of just a few lines to accomplish the task. All that is necessary is a good understanding of the power of LOGO's recursion.

The main idea to grasp is that a procedure which is called continues until it stops. Only then can the procedure which called it continue.

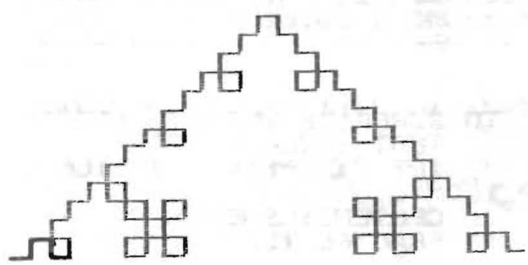
This concept is developed in some detail by Harold Abelson on pages 34-43 of his book, "Apple LOGO" (BYTE/McGraw-Hill, 1982). Abelson and diSessa also explore it in their text "Turtle Geometry," reviewed elsewhere in this issue.

The Apple LOGO (LCSI) listing in this article gives you first a procedure called SHAPE, which will draw the basic figure first shown above. Work with it until you are familiar with it in various orientations and sizes. See how it can be connected to make many interesting patterns.

Next, consider the remainder of the listing. FRACTAL will draw the SHAPE of a certain size to a desired depth of repetition. Note that the TEST for DEPTH = 0 will STOP a procedure if it is true. This is one of the keys to understanding how this procedure works.

Also note that, instead of FD :LENGTH along a side of the figure, FRACTAL calls itself with :LENGTH/3 and :DEPTH-1. Thus, its own shape can take the place of a side at a particular depth of repetition.

Here is what FRACTAL at a DEPTH of 3 looks like.



continued on page 8

Fractal continued

CENTER is just a housekeeping procedure to align the drawing horizontally in the center of the screen.

SURPRISE is the final result, all ready for you to use. Just as an opener, here is what the figure looks like at a DEPTH of 5. The surprise is the unexpected (?) appearance of a corner.

Now you can go back to some of the patterns you made with SHAPE and change SURPRISE to make some incredibly intricate designs.

```
TO SHAPE :LENGTH
    FD :LENGTH
    LT 90
    FD :LENGTH
    RT 90
    FD :LENGTH
    RT 90
    FD :LENGTH
    LT 90
    FD :LENGTH
    END

TO FRACTAL :LENGTH :DEPTH
    TEST :DEPTH = 0
    IFT [ FD :LENGTH STOP ]
    FRACTAL :LENGTH/3 :DEPTH-1
    LT 90
    FRACTAL :LENGTH/3 :DEPTH-1
    RT 90
    FRACTAL :LENGTH/3 :DEPTH-1
    RT 90
    FRACTAL :LENGTH/3 :DEPTH-1
    LT 90
    FRACTAL :LENGTH/3 :DEPTH-1
    END

TO CENTER :LENGTH
    CS PU HT RT 90
    BK :LENGTH/2 PD
    END

TO SURPRISE :LENGTH :DEPTH
    TEST :LENGTH >243
    IFT [ PRINT [ TOO LONG. ]
STOP ]
    CENTER :LENGTH
    FRACTAL :LENGTH :DEPTH
    END
```

continued

Incidentally, if you have a desire to explore fractals in a more formal sense than that presented here, you are referred to "Fractals: Form, Chance, and Dimension" (W. H. Freeman pub., 1977), by Dr. Benoit Mandelbrot, the father of modern fractal study.

FORWARD 100! ......

From the NLX Mailbag

The article "Tipps for Teachers: Distance and Direction" written by Steve Tipps is excellent. Every paragraph includes a meaningful instructional strategy. I look forward to the next issue of The National LOGO Exchange.

Grace E. Shope
Abington School District
Abington, PA

TERC Announces Computer Workshops

Technical Education Research Centers Inc., a non-profit public service corporation well known for its LOGO involvement, has announced the dates and sites for its workshop series, Microcomputers in Education, for the fall and winter.

Special emphasis will be given to LOGO. However, other topics also will be covered, ranging from BASIC and PASCAL to Administrative Uses of Microcomputers. Machine language, graphics, and instructional use of computers round out the subject area.

These workshops are designed for professional development for educators at all levels, elementary school through college. Each workshop emphasizes hands-on experience with several different microcomputers.

Participants receive a hefty packet of practical reference materials. Special evening symposia are usually held to review current topics and issues in the field of computers in education.

The schedule is as follows:

October 19-21	Westport, CT
November 8-10	Cambridge, MA
December 7-9	St. Louis, MO
December 13-15	Boulder, CO
January 18-20	Tallahassee, FL
February 7-9	Washington, DC
February 17-19	New York, NY

For more information, write Ms. Sharon Woodruff, TERC, 8 Eliot St., Cambridge, MA 02138, or call (617) 547-3890. Mention that you read about them in The National LOGO Exchange.