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*Let's Get Rich: A Study in Big Numbers and the Power of Doubling*
*Logo Puts It All in "Perspective"*
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And then there was LogoWriter followed by Logo PLUS, and then there was Object Logo, and now there is MicroWorlds®. We might even add HyperCard to the above list since so many Logo enthusiasts found a familiar environment in HyperCard.

As those of you who are loyal LX readers or Logo users know, Logo has gone through a long and varied evolution. The first version of Logo ran on large computers, before the days of the Apple II and the Radio Shack TRS-80s. This early version included only list processing—it didn’t even have a turtle. In the early 1980s, versions of Logo for the first Apple II computers appeared and captured the imaginations of thousands of teachers. Logo was an absolutely amazing piece of software in those early days. It had capabilities that were far beyond most other kinds of software of the time.

As brands of microcomputers proliferated, so did versions of Logo. Nearly every kind of “personal” computer had at least one version of Logo available. However, other early software evolved as well. It wasn’t long until word processors of the time were both cheap enough and powerful enough that using the Logo editor as a text processor no longer made sense. And using Logo wasn’t simple—many of you remember struggling with management of workspaces, editing, and saving, no matter what version of Logo you were using. All of those Logos in the early ’80s were based on very much the same model.

Then, in 1982, LogoWriter burst on to the scene. LogoWriter gave us a whole new interface for Logo. It had a “real”—if not powerful—word processor. It more closely followed what users expected it to do. Workspace management became a non-issue because graphics, text, and procedures were all saved as a single file. While not everyone preferred this new Logo environment, there was no question that it represented a significant change in the way we think about Logo. Over the next few years, we saw a number of LogoWriter features incorporated into other Logo versions.

While LogoWriter provided an easy entry point for novices, many users longed for a sophisticated, high-end Logo. Those Logophiles found their needs met by Object Logo. Object Logo provided a “no ceiling” environment for those interested in object-oriented programming.

Yet other Logo users became enamored with HyperCard. In HyperCard they found an environment that made the creation of products easier and more user-friendly. In fact, there were so many Logo users moving into HyperCard that the issues surrounding HyperCard and Logo use not infrequently were addressed in the pages of this journal.

In recent months, we have seen a number of new Logos appear. Several of these Logos are free for the taking from the InterNet. They are labors of love by their authors and have particular features that appeal to certain types of Logo users. But most of these Logos are also not likely to find themselves commonly used in schools.

However, it appears that the very latest addition to the plethora of versions of Logo seems likely to radically change the way we think about Logo. LCSI will shortly have available a new product they are calling MicroWorlds. MicroWorlds will be aimed both at new Logo users and at the existing body of dedicated users. New users will be supported by print materials to help their students get started. Long-loyal Logo users will find the familiar Logo language enhanced by many new capabilities.

It is simply not possible to describe MicroWorlds in a few words. At its heart is the familiar LogoWriter dialect of Logo. LogoWriter users will feel quite comfortable with the Command Center, Page, and the language itself. MicroWorlds has added “Centers” to its immediate mode features. There’s a Shapes Center for choosing, identifying, and editing shapes. There’s a Drawing Center for working with the familiar Macintosh Paint tools. (MicroWorlds only runs on color Macintosh computers.) The Tool palette is reminiscent of HyperCard. You can make buttons and text boxes (fields). You can also make sliders, a fascinating feature that assists in making the concept of variables more transparent.

First There Was Logo...

by Sharon Yoder
As Marian Rosen said in a recent article about Logo Writer, "But wait, there's more!" Shape sizes can be changed. Any number of turtles can be used. Turtles move about under mouse control. More importantly, parallel processing is now possible. That means you can play that song and draw that graphic at the same time—at last!

While Logo has been an important part of my life for many years now, I have to admit that I'm more excited about MicroWorlds than I have been about a new Logo product for a long time. It has the potential to expand the way we think about Logo, and it has the potential to compete with HyperCard in some contexts. If you get a chance, take a first-hand look at MicroWorlds. If not, stay tuned. We'll be having articles about MicroWorlds in LX in the coming months. If you want more information, contact LCSI (see ad on the inside back cover)

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Volume 11 Number 4
LX114
I heard a story recently about a man who was chopping wood with an old ax. It wasn’t just any ax he was using. It had belonged to his grandfather, and had been passed on to him by his own father some years ago. He was very proud to be using his grandfather’s ax.

Suddenly, on one particular swing, the thin metal part on the head of the ax around the handle cracked. The man turned a sad situation into a happier one by replacing the cracked ax head with a brand new one.

Later, he told his elderly father about the incident and how sad it made him feel to have broken the ax. His dad replied, “Yep, Son, I sure know how you feel. Something like that happened to me, too. Once when I was chopping wood with that ax, I broke the handle. It really made me sad, but I felt better when I replaced the broken handle with a new one.”

Is this still his grandfather’s ax? If you asked the man, I’m sure he would say it is. Even though none of the components are original, the ax nevertheless gives him a connection with his grandfather. The “ax-ness” (for lack of a better word) bridges the gap in space and time.

It occurred to me that a Logo procedure (a tool) is like the grandfather’s ax. It performs a useful task, but it might have been changed by the different students through whose hands (disks) it has passed.

For example, Lisa invented a new SQUARE procedure.

```
   TO SQUARE
   REPEAT 4 [RT 45 FD 100 RT 45]
   END
```

Jason personalized it.

```
   TO JASON
   REPEAT 4 [RT 45 FD 100 RT 45]
   END
```

Dana decided to make it variable, but liked the procedure name.

```
   TO JASON :SIZE
   REPEAT 4 [RT 45 FD :SIZE RT 45]
   END
```

Is this still Lisa’s procedure?

To be truthful, this question doesn’t really matter. What does matter is that the tool procedure has been passed from one student to another and another because of its function (its SQUAREness). If one part “breaks” or does not function as a student wants, then he or she can just “repair” it so it operates in the way desired.

Why not pull out some of those student- and teacher-written procedures from earlier times and take another look at them? Maybe they can be “repaired” so that they can do something surprisingly useful.

FD 100!

Tom Lough
Founding Editor
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Simsbury, CT 06070

---

**Logo Robotics for the Macintosh**

The official name of the Paradigm adapter that allows Apple II or IBM LEGO-Logo robotics kits to be used with a Macintosh is the “Pearl Controller.” The price of the Pearl Controller at the time this was written was approximately $200, but due to rapidly changing circumstances that can take place in technological settings, it may be advisable to check with Paradigm about current hardware and software configurations. The Paradigm Pearl Controller and the accompanying LEGO-Logo emulation for the Macintosh can be obtained from:

Paradigm Software, Inc.
FO Box 2995
Cambridge, MA 02238
Phone: 617/576-7675
FAX: 617/576-7680

The LEGO-Dacta Control Lab robotics system for the Macintosh should be available in the late summer or early fall. Those who wish to obtain more information about this system can call the following toll-free number:

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---

*Grandfather’s Ax* by Tom Lough

*Logo Exchange* Summer 1993
Do you ever run out of ideas for Logo projects? For some people, Logo inspires a never-ending supply of interesting projects and ideas. But others are always on the lookout for new things to try. With these folks in mind, Terrapin recently published *101 Ideas for Logo*, a book full of projects for all levels of Logo fun. Almost all of the ideas will work with any version of Logo. The book doesn't teach Logo—instead, it offers project ideas. Some contain helpful tips, strategies, and explanations. Others are bare-bone ideas, letting the reader explore different approaches and solutions.

*101 Ideas for Logo* offers five areas of exploration—Graphics, Turtle Fun (shapes, animation, and multiple turtles), Word Play, Number Fun, and Music—with many ideas combining more than one area. The book challenges the reader to design a T-shirt, make a Logo jigsaw puzzle, create an adventure game, animate a space scene, play rounds and duets, choreograph a half-time show, invent new proverbs, computerize a restaurant menu, write a slot machine game, and much more.

The ideas are divided into five levels, each of which assumes a set of Logo skills. The 25 projects in Level I are great for beginners—they require no procedure writing. In the 35 ideas of Level II, the reader begins to write and combine simple procedures. Level III explores variables, words and lists, and reporters. Level IV incorporates tail recursion and decision making. The Level V ideas present complex problems, requiring sophisticated programming skills. The 101 ideas are designed for grades 3-10 in school or at home.

Here is a sampling of 3 of the 101 ideas to give you projects to try over the summer (and a peek at *101 Ideas for Logo*). Like many of you, my inspiration for Logo ideas comes from all kinds of sources—Butterflies from my love of nature, Ye Olde Pyramid from a Nova program on PBS, and Word Changes from my curiosity about words.

---

**Butterflies**
(a Level I idea)

Do you remember the Total Turtle Trip Theorem? It says:

*For the turtle to draw a shape and end up right back where it started, heading in the same direction, it will turn a total of 360° (or a multiple of 360).*

This works for squares, and it also works for circles. The sum of all the turns should equal 360°. How would you complete this instruction to draw a circle?

```plaintext
REPEAT 360 [FORWARD 1 RIGHT ___ ]
```

Could you also draw a circle by starting with REPEAT 20? What would be the turn number?

```plaintext
REPEAT 20 [FORWARD 10 RIGHT ___ ]
```

The turtle will complete the shape if the turn number is 18. Why? Because 18 * 20 = 360. Since the shape has
many sides (20 to be exact), it looks quite round. It looks almost as round as the one drawn using the REPEAT 360 instruction. The turtle draws it much faster, too.

How could you draw a larger circle using a REPEAT 20 instruction? How about a smaller circle? Which number would you change?

Practice drawing circles to the left and to the right. Which part of the REPEAT instruction list do you need to change?

Make circles of different colors and different sizes. Add a little circle for a head and maybe an antenna or two. Voila! You have a butterfly!

Ye Olde Pyramid
(a Level II idea)

Egyptologists, architects, and stonemasons have tried to figure out how the pyramids were built. The largest pyramid contains over two million tons of stone. It was built by tens of thousands of workers in less than 30 years.

Research shows that heavy stone blocks were placed onto a square foundation. Then the pyramid was built up in layers as stones were added.

Triangular pieces were placed on the edges to form the pyramid shape. This was called the casing. These triangular blocks were carefully sized to make the pyramid grow at the right slope.

Word Changes
(a Level III idea)

A prefix can change the meaning of a word. Happy becomes unhappy, agree becomes disagree, try becomes retry.

Think of all the prefixes you can use with "cooked": overcooked, undercooked, precooked, recooked, uncooked. How do you like your food?

It's fun to create new words by adding prefixes to words in Logo. How many prefixes can you think of? Keep your eyes and ears open for other prefixes as you read and listen. Write a procedure that reports a list of prefixes. (You can't use the name PREFIX if it is already the name of a Logo primitive. However, you could call it PFIX.)

The root word is the main part of the word. Think of root words that can use the prefixes in your list. Write a procedure that reports a list of root words.

Now, can you figure out how to combine a word part from each list? Use PICK and WORD with your two new procedure names. If PICK is not a primitive in your version of Logo, define the following procedure:

```
TO PICK :OBJECT
  OUTPUT ITEM 1 + RANDOM COUNT :OBJECT :OBJECT
END
PC Logo users should use this version of PICK:
TO PICK :OBJECT
  OUTPUT ITEM RANDOM COUNT :OBJECT :OBJECT
END
```

Here are some words that Logo might create. Some are not real words, but can you imagine what they might mean?

UNICYCLE
COHORT
RECYCLE
A suffix is a syllable that comes at the end of a word. A suffix can also change the meaning of the word. Are you careful or careless? Write a procedure to add suffixes to a root word. Can a word have both a prefix and a suffix?

Soon you'll be adding new words to your vocabulary, like SUPERHAPPYFUL. Happy Logo adventures!

101 Ideas for Logo is available from Terrapin Software, Inc. as a single-user book and as a site license, which includes the book and a set of reproducible black-line masters. For more information, see page 13.

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Circle # 20810
The LogoWriter World:
The U.S.A. Map and Time Zones
by Orlando Mihich

Introduction

My students always like to draw maps for their social studies classes. They particularly like, and are very proud of, their creations in LogoWriter. They add colors and text, so each map is unique—at times awkward-looking but clear in what it represents. The process is usually lengthy because students seek to create the “perfect map” by drawing and redrawing lines.

Students copy maps from their social studies books and from atlases. When the size of the map matches the size of the screen, they trace the map on a piece of transparent paper, paste the paper on the screen, and drive the turtle, following the traced lines. Recently, some of my students were drawing a map of the Mediterranean Sea and the Roman Empire. One student had the “boot” of the Italian peninsula looking east instead of west. The student had copied a very small map from the social studies book, a map that was too small to be traced on paper for transfer onto the screen, and had gotten lost in the process—a frustrating situation for everyone involved.

To help students generate more accurate drawings and avoid the map-size obstacle, using a grid—the “old masters technique”—is very helpful. For centuries before today’s Xerox revolution, this technique was used for copying, enlarging, and reducing drawings of all kinds.

Logo Maps

Students first draw a grid on the computer screen and number each vertical and horizontal bar of squares. Here, a $6 \times 9$ grid is usually quite adequate. Next on a piece of tracing paper they trace the state or continent. Next they draw a proportionaal $6 \times 9$ grid over the traced work. Now the map on the paper is broken down into squares and can be defined by the vertical and horizontal numbers. The students are ready to drive the turtle on the screen, from square to square, following the traced outline from the paper grid.

Before students start driving the turtle around the screen, we discuss ways to make the work easier and faster. Sooner or later they come up with a variation on Tom Lough’s “forward and back,” or fb, procedure:

```
to fb :size
  ht
  forward :size
  wait 25
  pe
  back :size
  pd
  st
end
```

With this procedure, students can evaluate a line several times before accepting it. When satisfied with a specific line, they simply change the fb into an fd and retain the value for the line. Students are further challenged to incorporate the above procedure into new procedures to turn the turtle right or left, and draw a line:

```
to r :angle :size
  right :angle
  fb :size
  left :angle
end

to l :angle :size
  left :angle
  fb :size
  right :angle
end
```

Here, too, students retain the numeric values by adding a “t” to the “r” or “l” before the first number and an “fd” to the second number. The final result in creating a map of the U.S. should look something like this:

![Map of the U.S.](image)

Summer 1993
The starting procedures are as follows:

to startup
  rg
  ht
  grid 30
  numbers 30
  usa.map
end

to grid :s
  pu setpos [-135 -89] pd
  rows :s
end

to square :s
  repeat 4[forward :s right 90]
end

to rows :s
  repeat 3[repeat 2[one.row :s forward :s * 2 right 180] forward :s * 2]
end

to one.row :s
  repeat 9[square :s right 90 forward :s left 90]
end

to numbers :s
  pu
  setpos [-132 -82]
  pd
  label.rows :s
  pu forward :s / 3
  right 90
  pu
  forward :s / 3
  pd
  label.columns :s
end

to label.rows :s
  label [1]
  next :s
  label [2]
  next :s
  label [3]
  next :s
  label [4]
  next :s
  label [5]
  next :s
  label [6]
end

to label.columns :s
  label [1]
  next :s
  label [2]
  next :s
  label [3]
  next :s
  label [4]
  next :s
  label [5]
  next :s
  label [6]
end
left 45
forward 6
left 45
forward 4
right 80
forward 25
left 35
forward 6
left 90
forward 3
right 90
forward 10
right 35
forward 20
right 55
forward 3
left 90
forward 12
end
to Pacific.West.Coast
right 90
forward 3
left 45
forward 20
left 90
forward 3
right 120
forward 25
right 15
forward 25
right 10
forward 30
left 10
forward 10
right 110
forward 16
left 110
forward 7
end
to Canadian.border
right 100
forward 75
left 10
forward 35
right 10
forward 25
right 125
forward 15
left 125
forward 8
left 45
forward 8
right 90
forward 6
left 90
forward 6
right 90
forward 6
right 100
forward 15
left 65
forward 20
left 45
forward 5
left 90
forward 5
left 45
forward 18
right 45
forward 8
right 25
forward 3
right 80
forward 15
left 70
forward 20
left 10
forward 10
left 90
forward 8
right 55
forward 13
left 30
forward 20
right 60
forward 5
right 45
forward 15
end
to Atlantic.East.Coast
right 90
forward 20
left 40
forward 5
left 45
forward 5
right 110
forward 15
left 90
pu
forward 4
left 100
pd
forward 5
back 5
right 100
pu
back 4
right 55

Summer 1993
\texttt{pd forward 25 right 90 forward 6 left 100 forward 6 left 90 forward 6 right 55 forward 12 right 80 forward 25 left 20 forward 16 left 60 forward 30 right 35 forward 8 end}

The generated maps are still individual, personal maps, but they are more accurate and easier to make. By the end of the project, students are masters in spacial orientation and, in addition, have learned a technique they may find helpful in the future.

In my social studies classes, students usually add to the completed maps the country's major cities, mineral deposits, dominant land use, flag, national anthem, and so on. The earth science curriculum is enriched by students creating their own weather maps, positioning weather fronts, and indicating temperatures and areas of high and low pressure. Students exchange their weather maps and make educated guesses to predict the movement of air masses and the next day's weather.

N.B. In his paper "Easy Map Drawing with LogoWriter" (\textit{Logo Exchange}, Dec./Jan. 1990), Professor Francisco Quesada of the Universidad de Costa Rica in San Jose, Costa Rica, introduces map-making procedures that automatically collect the list of instructions in the Command Center and carry them onto the flip side.

\section*{Standard Time Zones}

The earth's surface is divided into 24 standard time zones. In each zone, noon is set as the time when the sun is highest over the center of that zone. The time in each zone is one hour earlier than the time in the zone to the east, e.g., at nine o'clock in New York City, it is eight o'clock in Houston, and six o'clock in Los Angeles.

My eighth-grade students divide the U.S. map into the four time zones and add several cities around the country. Positioning the turtle in a starting city, they direct the turtle-plane to "set the heading toward" the destination city and fly to that city. In addition, they add a quiz asking the viewer to type the arrival time and to adjust his/her watch to the local time for the time difference. At the end of all flights, the program gives the number of correct and incorrect answers. My students are very creative, and every year they change the program, enriching it with new ideas in screen design and programming.

The quiz given below was written by Antonio Colondres on an Apple II GS. Antonio created five aeroplane shapes and had the turtle flying from New York to four cities in the U.S. At each stop, the viewer is asked to type the local time or to adjust his/her watch to the local time. If the answer is correct, the clocks on the screens change accordingly. At the end of the quiz, the program gives the number of correct and incorrect answers and the percentage of correct answers.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{map.png}
\caption{The quiz given below was written by Antonio Colondres on an Apple II GS. Antonio created five aeroplane shapes and had the turtle flying from New York to four cities in the U.S. At each stop, the viewer is asked to type the local time or to adjust his/her watch to the local time. If the answer is correct, the clocks on the screens change accordingly. At the end of the quiz, the program gives the number of correct and incorrect answers and the percentage of correct answers.}
\end{figure}

\begin{verbatim}
std times are as follows:

\texttt{to startup rg ht ct cc usa.map time.zones cities timeO introduction end}

\texttt{to timeO setc 1 pu setpos [95 -85] setsh 52 pd stamp pu setpos [25 -85] setsh 51}
\end{verbatim}
to introduction
make "correct 0
make "total 0
make "wrong 0
cc
type[Hi, my name is Antonio and your name is?]
type char 13
make "name readlistcc
ccc
type sentence [Type a key]:name
type sentence ", [and get ready for a tour of the United States and some questions.]
make "key readchar
question1
end
to go
if colorunder = 2 [stop]
pu
forward 1
go
end
to ny.sf
pu
setpos [98 36]
setc 2
setsh 2
st
seth towards [-118 13]
pu
forward 5
go
end
to question1
cc
type [Your plane leaves New York at 11 am and will reach San Francisco in 5 hours. What is the local time in San Francisco?]
tell 1

timel
make "wrong :wrong + 1
make "total :total + 1
make "key readchar
cc
question2
end
to timel
pu
setpos [95 -85]
setsh 52
pe
stamp
setsh 45
pd
stamp
pu
setpos [25 -85]
setsh 51
pe
stamp
setsh 44
pd
stamp
pu
setpos [-45 -85]
setsh 50
pe
stamp
setsh 43
pd
stamp
pu
setpos [-115 -85]
setsh 49
pe
stamp
setsh 42
pd
stamp
end
to ending
cc
type (se [You have] :correct [correct answers and] :wrong [wrong.] :name ".")
type char 13
type [Type a key.]
make "key readchar
cc
type [If you want to restart the program type R otherwise press any other key.]
type char 13
ifelse readchar = "R [time7 question1] [leavepage]
end

Time7 restores the clocks to the initial time0.

Orlando Mihich
Science and Computer Teacher
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Technology Learning For a Better Future
Let's Get Rich: A Study in Big Numbers and the Power of Doubling
by Robert Macdonald

There are many ways of creating educational microworlds. Teachers have been doing it for many years. This article will attempt to describe a few of them. All of them center around developing concepts for recognizing the immensity of large numbers. Given the size of our national debt, it is an area of mathematics that many Americans believe their national leaders have never learned about.

A Concrete Microworld

Ten years ago Ms. Arlene Rebeshini, a fellow teacher at the elementary school at which I then taught, came up with a CAP-tivating idea. She wanted to demonstrate to her students just what a million of something looked like. She had her class begin the endless task of collecting one million bottle caps.

This seemed more practical than corraling 100 elephants, then weighing them to discover how much they would weigh collectively; or, perhaps, counting all of the hairs on the heads of ten students to see if the sum would equal one million. In eight years, she was able to fill 40 x 2' boxes, plus other sundry containers, with caps. However, of these, 700,000 were donated by a Dr. Pepper warehouse. That donation made collecting too easy. So the students decided to go on for two million.

Everyone collected: students, parents, grandparents and other relatives, school personnel, and community friends.

To tally posed a problem. For years, Friday was tally day. Each Friday, the count was close to 5,000. Now bottle caps in such vast quantities pose another problem—weight. One day, a large container on a counter gave way from the pressure of weight. Cascading bottle caps create a lot of noise.

After eight years, Ms. Rebischini had to do something with her two million bottle caps. She wanted to recycle some of them, if possible. She thought about encasing a million of them in sculptured blocks of clear acrylic as a permanent art object on the playground of the school. However, this brought up other problems: Would the acrylic withstand Michigan weather? How costly would it be to lay a foundation and mount the art piece? As it turned out, costs would be high. Funding for the project was never realized. A permanent record of the achievement had to be abandoned.

Yet for eight years those bottle caps provided inspiration for a constantly changing group of elementary students. In addition to valuable lessons in math, the caps were used in some of Ms. Rebischini's art projects. Even the music teacher became involved: color-coded caps became solfege syllables when placed on a staff. The collection frequently inspired budding writers.

Alas, without funding, the collection had to be recycled, if for no other reason than that storage had become a critical problem. But there was one last encounter: my colleague decided to let the students frolic in one million unsouled bottle caps. So one million of the caps were poured onto the floor of the school's multimedia center.

Students pour a sea of one million bottle caps on the floor.

Students and staff cavorted in a sea of bottle caps. It truly was a CAP-tivating experience.
Continuing Work With Large Numbers

Entering the fourth grade after their bottle cap encounter, the students I inherited from Ms. Robischini’s class were eager to expand their horizons. I suggested using the computer to investigate large numbers. Little did I know that by the time we had finished our investigations in the late fall of 1989, the class would have involved Sharon Yoder, Eadie Adamson, Michael Temple, and the technical staff of the LCSI in Montreal (Adamson, 1989).

The class first suggested that we see how long it would take a computer to count to a million. Hopefully, I thought, it would take less than eight years. So I somwhat ineptly wrote the following Logo Writer program. (It’s important for students to realize that teachers aren’t always infallible. It keeps the teacher humble and may very well stimulate the students to greater effort.)

```
to count.up :input
    if :input = 1000000 [stop]
    insert :input
    insert char 32
    count.up :input + 1
end
```

Off we went with the program. In a short time the output slowed to a crawl. The class rushed a letter off to Sharon while I addressed one to Eadie. Together we penned a letter to the LCSI. (The letters were necessary because the telephone system that serviced our island elementary school would not tolerate a modem. The equipment was in place before this was discovered.)

Meanwhile, if I may be forgiven, I resorted to a BASIC program utilizing a simple FOR..NEXT loop:

```
10 FOR X = 1 TO 1000000
20 PRINT X,
30 NEXT
40 END
```

This worked with alacrity. And what was of visual importance—numbers scrolled off the screen in multiple columns. One student suggested we have a race with the three computers we then had in the room. One Apple IIe won the race in 3 hours and 25 minutes. The other IIe completed its task in 3 hours, 52 minutes, 30 seconds, followed by a IIc in 15 more seconds. This discrepancy in time, as Eadie noted in her reply to our letter, puzzled some technicians.

Help Arrives

Within a short time we received a reply from Sharon. She suggested the following changes to my Logo Writer program:

```
to count.and.clear :input :lines
    if :input = 1000000 [stop]
    if :lines = 18 [make "lines 0 ct]
    print :input
    count.and.clear :input + 1 :lines + 1
end
```

Sharon’s solution set up a counter that caused the text to clear. Her solution is also psychologically apt because it creates the illusion that numbers are scrolling off the screen. Her technical explanation of why my program failed was of interest to me but not to the average fourth grader:

Different versions of Logo parse or translate the Logo code differently. So the procedure that you sent me is parsed by Logo Writer as if it were embedded recursion—which it is not. That implies that a “pointer” is put on a stack in memory each time the procedure is called. It doesn’t take long to fill up the memory this way.

Sharon’s program took us 47 hours, 3 minutes to finish the count.

Further Aid

At about the same time Eadie’s letter arrived. Her solution was: Keep Things Simple! The fewer demands made on the program the swifter it will move. She suggested the following:

```
to countup :number
    print :number
    ct
    countup :number + 1
end
```
On an Apple IIGS the time of the output improved. One of Eadie's articles (Adamson, 1989) goes into detail on the varying solutions to problems such as this and is well worth looking through. The class did try out Eadie's and Michael Temple's suggestions. However, I found difficult to accept the thought of not producing output on the screen to hasten action. Constant visual proof of counting was necessary.

A reply from the technical staff of LCSI was an added plus for us. Each staff member had signed the letter, just as we had each signed ours. One student, Andy, had his day made. He recognized among the signatures the name of the author of his favorite program, the Phantom Fish Tank. The class presented him with letter as a memento. He deserved it for the work he was able to save them with his acute observations, which are detailed below.

In their letter, the LCSI staff recalled for us the tale of the tortoise and the hare, with a graphic picture of the outcome of that classic race. Granted, LogoWriter isn't speedy. But a race is a race, and a race between a tortoise and a hare doesn't happen every day. And a constant output on the screen for all of us in the fourth grade is a necessity. We're skeptics. (I also preferred to keep the class focused on the same software. The programs were never written in other Logo dialects.)

**How Far Can We Go?**

So LogoWriter can count to a million with the reliability of the tortoise. From there we wanted to discover the biggest number that LogoWriter could handle. I suggested that students start multiplying large numbers together with a print statement. For example:

```logon
print 76545678 * 25
```

I cautioned the students to develop some strategies to carry out their experiments.

Someone wanted the computer to print out each of the numbers that LogoWriter was able to handle. We knew it could handle one million. So let's go on. Thus, we created this slightly familiar program:

```logon
to go.big :number
  print :number
  wait 5  ; We wanted to see the number.
  ct
  go.big :number + 1
end
```

But our friend Andy didn't think we should tie up one of the computers for all of that time. He remembered the output of a palindrome program we had tried a few weeks before. (Good memory!) He had saved a printed listing. (I don't think I can attribute this to foresight. Few fourth graders like to clean out their desks.) When we attempted to make a palindrome of 89, it went through 23 generations and ran out of space with:

```
955594506548
+ 845605495559
```

Andy theorized that we should use the go.big program and input 99999999990. He suspected that the computer wouldn't go to one quadrillion. He was right. The Apple IIE stopped at 99999999999999.

While the students were experimenting with larger and larger numbers, I went to work on a computer program to turn them all into millionaires through the power of doubling (Bloster, 1983).

**The Problem—Becoming a Millionaire**

How long would it take you to become a millionaire if I were to give each of you one dollar on Day 1, and then double that amount each day thereafter? You are to save all of your money.

A worksheet was necessary to keep track of the students' finances (see the worksheet at the end of this article).

<table>
<thead>
<tr>
<th>DAY</th>
<th>SAVINGS</th>
<th>TOTAL SAVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$1</td>
<td>$1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Students should be permitted to use calculators. It is important to underline the importance of the doubling under the column of savings. The constant tally that takes place in the third column is essential.

A computer program that outputs the solution is provided below. I suggest that the class itself take care of gathering information and checking their work on assignments of this sort. Fourth graders can easily organize their material and carry out this work with little or no teacher intervention. Teachers are busy enough.

```logon
to get.rich
  introduction
  initialize
  set.up
  save
  end

to introduction
  clearpage
  print []
  tab
  print [LET'S GET RICH]
  print []
  print []
```

`Summer 1993`
wait 30
print [How many days would it take you to]
wait 50
print [save $1,000,000 if you were to start]
wait 50
print [on day one with one dollar and were]
wait 50
print [to double your savings each day?]
wait 50
print []
print [You are not expected to spend any]
wait 50
print [of your savings. Be certain that]
wait 50
print [you total everything.]
wait 50
wait 50
print []
print []
tab
print [GOOD LUCK! HAPPY SAVINGS!]
end
to clearpage
if not front? [flip] rg ct ht cc end
to initialize
end
to set.up
print []
tag
insert [DAY] tab insert [Savings]
tag
print [TOTAL]
print []
tag
insert :days
tag
insert :savings
end

The command to operate the program is get.rich. What could be simpler?

References

101 Ideas for Logo

Terrapin Software, Inc. announces a new publication, *101 Ideas for Logo*. This collection of classic and new Logo project ideas is suitable for use in the classroom or at home. The projects are organized into five skill levels and involve all areas of the Logo language. Compatible with all popular versions of Logo, these ideas range from beginning explorations to challenging programming problems.

*101 Ideas for Logo* is available as a book or in combination with reproducible black-line masters as a school site-license.

For more information, contact:
Terrapin Software, Inc.
400 Riverside Street
Portland, ME 04103
800/972-8200
207/878-8200

*Logo Exchange* 17
How many days would it take to save one million dollars if you were to start on Day 1 with one dollar and were to double your savings each day? You are not expected to spend any of your savings.

<table>
<thead>
<tr>
<th>Day</th>
<th>Savings (dollars)</th>
<th>Total Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
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</tbody>
</table>

If you need more space, continue on the back of this sheet.
"There's something wrong with this picture" probably sounds familiar to many art teachers. One reason why the student artist may feel this way is that he or she has not yet learned how to draw in perspective and does not realize that proper perspective makes a drawing look more realistic. Perspective is generally a difficult concept for students to grasp, and equally difficult for teachers to teach. Students traditionally learn about perspective by trying to reproduce on paper what they see in real life or by copying a picture that has already been done correctly.

A unique approach to teaching students about perspective is to introduce them to turtle geometry and the way in which Logo can help students visualize the concept of drawing in perspective. As students experiment with the turtle and geometric shapes, the concept of perspective will emerge as a more natural process as the students see the relationships between what they can draw with the turtle and how they can transfer their new knowledge of perspective to paper and pencil.

Perspective in general has to do with where the artist is looking as he or she is drawing. For example, look at this drawing.

The horizon and vanishing point (the point at which all parallel lines converge) are at the center of the picture, right at eye level. When the artist is drawing from the perspective of eye level, it is called one-point perspective, which is what will be emphasized in this article because it is the most basic and easiest to understand. One-point perspective will be demonstrated by using triangles, rectangles, and cubes. The above figure started with a straight line to represent the horizon and the top angle of an equilateral triangle as the vanishing point.

```
to horizon
pu
setpos [-115 85]
seth 90
pd
forward 220
end
to triangle.1
pu
setpos [80 -85]
seth 270
pd
repeat 3 [forward 195 right 120]
end
```

To demonstrate the concept of the vanishing point with the turtle, draw another triangle inside the larger one. To do this, it is easiest to either imagine or draw a line bisecting the first triangle so that you have two right triangles.

This is helpful in figuring out lengths of the sides and the angles of the two isosceles triangles that have been created.
Once the triangles and the horizon have been created, you can experiment with equal spacing in perspective. Think of the isosceles triangle as railroad tracks. How would the railroad ties be placed so that they were spaced accurately as they vanish into the horizon? Using rectangles as railroad ties, place the first tie on the tracks and then place a second tie any distance from the first one.

\begin{verbatim}
  to triangle.2
      forward 97.5
      right 90
      pu
      forward 169
      seth 180
      left 15
      pd
      forward 176
      back 176
      right 30
      forward 176
      end
\end{verbatim}

Once the triangles and the horizon have been created, you can experiment with equal spacing in perspective. Think of the isosceles triangle as railroad tracks. How would the railroad ties be placed so that they were spaced accurately as they vanish into the horizon? Using rectangles as railroad ties, place the first tie on the tracks and then place a second tie any distance from the first one.

\begin{verbatim}
  to rectangle.1 :sidel :side2
      pd
      repeat 2 [forward :sidel left 90
                  forward :side2 left 90]
      end
  to rectangle.2 :sidel :side2
      pd
      repeat 2 [forward :sidel right 90
                  forward :side2 right 90]
      end
\end{verbatim}

To accurately space the rest of the ties, begin by setting the position of the turtle at the left short side of the first rectangle and have the turtle draw a 45-degree line from the top of the first tie on through the second tie to the track. That is where the third tie will be placed. Then set the heading of the turtle to 270 degrees and begin the process again. Draw a 45-degree line from the third rectangle through where the fourth tie would be placed and on until the line reaches the track. That is where the fifth tie will be placed. Continue this process until the line reaches the horizon. (These procedures were tested on the IBM version of LogoWriter and may not work as precisely in other versions.)

\begin{verbatim}
  to tracks
      tie.1
      tie.2
      tie.3
      tie.4
      tie.5
      tie.6
      tie.7&8
      end
  to tie.1
      seth 90
      rectangle.1 93 20
      left 75
      pu
      forward 40
      right 75
      end
  to tie.2
      rectangle.1 72 16
      right 105
      pu
      forward 40
      seth 0
      forward 8
      right 45
      pd
      forward 100
      left 75
      pu
      back 5.5
      seth 270
      end
\end{verbatim}
There are three concepts being demonstrated in this article. The first is the horizon along with the triangles, which demonstrates the vanishing point. For this, the user can type horizon, then triangle.1 and then triangle.2 to see the process build. Note that triangle.2 cannot be built by itself—it must follow triangle.1.

The second demonstration is that of equal spacing. This, too, is a building process. The user can start by typing horizon and then triangle.1 and then triangle.2. The user can next type tracks to see the whole process. Or the user can simply type equal.spacing and get the same result with fewer steps.

The third demonstration on on-point perspective using Logo involves inscribing a cube inside the same triangles used earlier. This will show students how the perspective of a three-dimensional object looks when drawn at eye level.

to equal.spacing
horizon
triangle.1
triangle.2

tracks
ht
end

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Once the cube is inscribed inside the isosceles triangle shown below, it is easier to visualize the cube if certain lines of the triangle are erased.

```logo
to cube
1.point
erase.the.lines
end
to erase.the.lines
pu
forward 19
right 105
pe
forward 70
seth 90
pu
forward 70
left 105
pe
forward 70
seth 270
pu
forward 53
left 90
pe
forward 16
pu
left 90
forward 72 left
90
pe
forward 16
ht
end
```

The user can save several steps by typing `cube`. The approach the user takes depends on whether he or she wants to see the step-by-step building process.

Thus, you can type `horizon`, `triangle.1`, `triangle.2` (but not without first typing `triangle.1`), `equal.spacing`, `1.point`, and `cube`. You can start with any of the three demonstrations by typing the new procedure name. The only procedures that will not work by themselves are `triangle.2`, `tracks`, `3.D`, and `erase.the.lines`, because each of these is a part of the process and is not of use in isolation.

This technique of drawing inside of geometric figures is one that can be easily transferred to paper and pencil.

This technique for learning perspective should be used by students who are experienced enough in drawing to want to learn about perspective. Any art instructor with access to a computer can use Logo as an instructional medium. If students are interested in learning the concept of perspective, they will probably have fewer reservations about learning if they are given the opportunity to experience turtle geometry. Give students as little direction as possible because part of the learning process is discovering new ways to use old information. After the students have experienced perspective using Logo, show them how it can be applied to drawing with a pencil on paper. It will make them eager to experiment further with Logo and expand not only their knowledge of drawing but of programming and problem-solving as well.

Note that the procedures in this article were tested on IBM LogoWriter. They may not work as precisely in other versions.

Nancy Flynn wrote this article while a graduate student at the University of Nebraska at Omaha. She has since graduated and is now an instructor in microcomputer technology at Metropolitan Community College in Omaha.

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LEGO Robotics in a Macintosh Environment

by Glen L. Bull and Gina L. Bull

The LEGO-Logo robotic system never fails to captivate both teachers and children. The instructions and documentation for the LEGO-Logo kits are their great strength. We usually ask teachers to work together in teams of two or three when they begin working with LEGO-Logo. There is almost always someone in the group with LEGO experience; those who never had the opportunity to tinker with LEGO parts as children usually find it satisfying as adults.

Increasing numbers of classrooms have acquired inexpensive Macintosh computers such as the Macintosh LC. We have been faced by the prospect of teachers who have existing Apple II LEGO-Logo systems that they wish to use with their new Macintoshes. By the time this issue of Logo Exchange appears, at least two choices should be available.

Control Lab

Control Lab is a LEGO-Dacta product scheduled for release in late summer or early fall. Although it is still under development as this is written, and therefore is subject to change, the initial release was targeted for technologic explorations in middle schools and above. The software for Control Lab has been developed by Logo Computer Systems, Inc. (LCSI), creators of the popular LogoWriter environment. The Control Lab system includes a Logo environment that lacks turtle graphics but provides Logo tools for reading sensors and controlling robotic motors.

Although Logo without a screen turtle may seem a radical departure, evolution and renewal are an important part of the technologic cycle. The last issue of Logo Exchange contained two articles on the future of Logo, asking "Will Logo survive?". Innovative products such as Control Lab that capture the spirit of the Logo philosophy in new forms may represent one of the best answers to this question. When the final version of Control Lab is completed, we hope to devote a full column to a review of this robotics system.

The Paradigm Robotics Controller

Another Logo robotics product for the Macintosh is equally innovative but fills a different niche, we believe. Paradigm Software has developed a robotics controller that allows an existing LEGO-Logo Apple II or IBM robotics kit to be used with a Macintosh. The Paradigm system offers three benefits:

1. It provides a solution for the Logo traditionalist who wants both the Logo turtle and LEGO-Logo robotics for their Macintosh.
2. It provides an upgrade path for teachers who wish to preserve their investment in an Apple II LEGO-Logo system by adapting it for use with a Macintosh.
3. It allows teachers to continue to use existing (and excellent) LEGO-Logo robotics documentation developed for separate grade levels (elementary, middle, and high school).

The Paradigm system has two components:

1. A hardware adapter that allows the LEGO-Logo interface to be connected to a Macintosh serial port
2. Software that provides the user with access to traditional LEGO-Logo commands

The hardware adapter worked perfectly. It only took a minute to attach the adapter to the LEGO-Logo interface and connect it to the Macintosh. This was facilitated by an intelligent, unambiguous design, supplemented by clear instructions in the manual.

The software provides several options, including an emulation of the LEGO-Logo commands within Object Logo, as well as an emulation of the LEGO-Logo commands within HyperCard. Paradigm is the distributor of Object Logo. Object Logo includes the usual features of Logo, but also provides access to object-oriented programming. Object-oriented systems make it possible to program by defining a set of behaviors for
an object. This innovative system that extends the Logo environment has received considerable acclaim and is worthy of a column in itself.

It is possible to program directly within the Object Logo environment to control the LEGO robotics system. However, many teachers will want to continue to use the LEGO-Logo commands and environment. Paradigm provides a LEGO-Logo emulator to meet this need. The LEGO-Logo emulator allows the existing LEGO-Logo documentation to be used with minimal changes. The ideal transition for a teacher currently using an Apple II LEGO-Logo robotics kit would be a LogoWriter Robotics software system for the Macintosh. However, since this option is not available (at least at the time this was written), the Paradigm LEGO-Logo emulation for the Macintosh provides the next best solution.

Hyper-Logo

The Paradigm system also provides an option offered by no other commercial product: access to LEGO-Logo commands from within HyperCard. HyperCard is a popular authoring system developed for the Macintosh by Bill Atkinson. The HyperTalk programming language shares many of the attributes of Logo.

- Both are procedural languages, with procedures that can communicate with one another through inputs and outputs.
- Both are interactive languages.
- Both support recursion.
- Both are extensible, and provide the capability to add to the language new commands that can function just as though they were built-in or primitive commands.

We have found that students who are familiar with Logo can easily make the transition to HyperCard and the HyperTalk programming language. Since Apple provided a complete version of HyperCard with each Macintosh for many years, it is readily available.

The concept of a programming environment with a low threshold and no ceiling was central to the original vision of Logo. The intent was not only to provide an environment that would allow even young children to control the computer in fulfilling ways in their first encounter, but also to provide a power of expression that would not limit advanced learners. We believe that LEGO-Logo commands within HyperCard can extend the Logo environment in a positive fashion.

The Paradigm robotics interface can provide a useful bridge between Logo and HyperCard within a Macintosh environment. We would recommend using the Paradigm LEGO-Logo emulator initially in conjunction with the LEGO-Logo documentation and projects. Depending upon the age of the group, one of the simpler projects, such as the computer-controlled traffic light, may be appropriate, followed by more complex projects, such as the LEGO floor turtle, as the group gains experience. We find that groups of two to four students work well.

The sample LEGO-Logo projects have the advantage of extensive testing with the age groups for which they are designed. As groups gain experience, they frequently develop extensions of sample projects or create original ones of their own.

A Sample Design Project

The LEGO-Logo merry-go-round project is a good example of the type of project that can serve as a bridge between a Logo environment and an enhanced project in a HyperCard environment. We have watched numerous groups of students successfully construct a carousel following the sample LEGO-Logo project directions. These directions include one booklet that provides step-by-step directions for putting together the LEGO parts to build a merry-go-round driven by a computer-controlled motor, and a second booklet that offers sample Logo procedures for controlling the carousel.

Once a group has a gained the confidence that comes from successfully completing a project of this kind, project extensions and elaborations are in order if there is sufficient time. One extension that we have found to be a natural elaboration of a project of this kind is the design of a computer control panel.

In a project of this kind, we find it useful to ask groups to create a set of design specifications. For example, a set of functions which might be specified could include the following:

- start and stop the carousel
- control the speed of the carousel
- allow each seat on the carousel to be advanced for loading and unloading of passengers
- provide a counter that allows the operator to monitor the number of revolutions of the carousel that have elapsed during the current ride

Depending upon the enthusiasm of the group, other functions might also be included. These could include settings for a long or short ride, controls for a sedate or exciting ride, and other functions limited only by the imagination of the group.

The next step in the development process involves graphic design. The graphic design process should group logical functions together to facilitate use by the operator. Sometimes it is helpful to provide older students with articles that discuss good and bad examples of industrial design. Any of the common Macintosh paint or drawing tools can be used for the graphic design component, such as those found in ClarisWorks or Microsoft Works, or the paint tools available in Hyper-
Card can be used for this process. The following illustration provides an example of a control panel developed by one group.

![Computer-Controlled Carousel](image)

This control panel provides buttons to start or stop the carousel and to set the speed and direction. A counter at the top displays the number of revolutions that the carousel turned since the beginning of the ride. This counter could also form the basis for programming decisions such as the length of the ride.

**Logic and Programming in a Robotic Environment**

After the control panel has been designed, the next step is the programming itself. For those who are not familiar with the LEGO-Logo environment, a control box provides three ports into which LEGO motors can be plugged.

![LEGO Controller Ports](image)

If a motor is plugged into Port A (which, to avoid confusion with the Macintosh serial ports, is referred to as “Slot A” in Paradigm documentation), a LEGO-Logo procedure to turn on the motor might be written in the following way:

```
TO MOTOR.ON
TALKTO "A"
ON
END
```

A HyperTalk procedure would be written in almost the same way as the Logo procedure. HyperCard makes buttons that can be clicked to initiate events. For example, buttons could be created to start or stop the carousel. Each button can have an associated procedure or script that describes what should happen when the button is clicked.

![HyperCard Buttons](image)

For example, in the case of the STOP button, the following procedure could be written. This procedure says that when the mouse button is clicked (on `mouseUp`), HyperCard should talk to the motor connected to Port A and tell it to turn off.

```
on mouseUp
   talkTo "A"
   off
end mouseUp
```

As you can see, the Logo procedure and the HyperTalk procedure are similar. The main difference is that the HyperTalk procedure can be associated with a button on the screen of the computer, making it possible to create the type of control panel shown in the illustration above.

**Instructional Connections**

There are both technologic and instructional lessons that can be obtained from working in an environment of the kind described above. In the future, almost all computers will have a graphical user interface that supports multiple windows with different applications. The process described above can demonstrate how multiple applications in different windows can be used in conjunction with one another—specifications can be developed with a word processor followed by procedures developed and tested in a LEGO-Logo environment with a graphics design for a control panel created with a paint or drawing program, leading to all of the above ultimately being combined within HyperCard to create the final product.

The instructional process is perhaps even more interesting than the technologic benefits. The steps of this process involve the following instructional areas in a single, multidisciplinary project:

- physics and mechanical skills—the carousel is constructed with motors, gears, and LEGO parts.
• electrical and electronic concepts—the motor and sensors must be connected to the interface box.
• writing and language arts—the specifications for the control panel must be developed and justified.
• art and graphic design—the layout of the control panel must be developed.
• programming and logic skills—the procedures needed to make the control panel operational must be developed.

One of the positive aspects of the above list that we particularly like is the fact that all of these elements are ultimately tied to real-world events—whether the carousel turns in the desired fashion. We have found that students with proper support will persist in their efforts to design and create the perfect carousel for extended periods of time, and they obtain considerable satisfaction when they achieve the goals they have set for themselves.

Summary

In the future, all computing environments will provide access to windows with multiple applications and a graphics user interface. The Paradigm controller allows teachers with Macintoshs who have existing Apple II LEGO-Logo robotics sets to preserve their investment by providing an upgrade path that allows them to use these systems with the Macintosh. Although we would prefer to see development of LogoWriter Robotics software that supports the Macintosh, Paradigm has done an excellent job of emulating the LEGO-Logo environment. In addition, this is currently the only commercial product that allows LEGO-Logo robotics systems to be controlled with HyperCard. Paradigm is to be commended for developing an excellent product that meets a real need.

This is likely to be a rapidly developing and changing area. We will report on future developments as they become available.

For more information on the products described in this article, see box above.

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WIN-LOGO is Available

WIN-LOGO is an environment for learning and developing applications in Logo language in a windows-like user interface. WIN-LOGO's graphical interface is indistinguishable from popular windows based applications. Pull down menus and dialog boxes provide quick access to many features. Traditional Logo systems users should feel at home with the easy to use interface.

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The Text window resembles a roll of paper, which can be scrolled up and down. It makes use of different fonts and the color of the foreground and background can be chosen.

When the Work window is resized, the contents will be rewritten to fit the new size. An arrow key can be used to display any previously written text, and pressing Enter on any line of the text causes WIN-LOGO to run that command.

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Journal Excerpts
by A. J. (Sandy) Dawson

In an earlier column this year, I mentioned that during the fall of 1992 I would be working with a group of 12 secondary school mathematics teachers (6 of each gender), all but 3 of whom are enrolled in a master's degree program, focusing on secondary school mathematics, at Simon Fraser University.

That course is now over. We used Borasi’s (1992) book Learning Mathematics Through Inquiry as the focal point of many discussions in the class. Students in the course wrote book reports, kept journals, led their colleagues through a wide variety of mathematical learning experiences, wrote their biographies as mathematics teachers, did some action research with the pupils they were teaching, talked, argued, debated with each other, and devoted one class meeting to a visit to the new school where one of them was teaching.

The teacher in that new school, Beth Mehrassa, kept a reflective journal as one of the assignments for my course. It is with her permission that I share some of the entries in her journal with Logo Exchange readers.

I was pleased when she approved of the selections I made from her journal for inclusion in this article. Because Borasi’s book formed the basis from which the course was launched, and upon which the course ended some 13 weeks later, let me begin by letting you in on Beth's initials thoughts about Borasi's book.

October 10th: When I first read Borasi's book, I found it interesting and its style immediately appealed to me. I enjoyed the students' comments as well as Raffaella's reflections as a teacher and a researcher. Despite this, I did not find much of it relevant to me as a teacher for I felt it was not applicable to my teaching. This was before I undertook a teaching assignment at the new Thomas Haney Secondary School. After working there for one month, I found much that I can apply from Borasi's book.

The new school where Beth chose to teach is not typical of secondary schools. It enrolls students in grades 8 to 12, and has scheduled classes for eighth graders as well as some selected courses in grades 9 to 12. For the majority of courses, however, students work through self-directed learning guides prepared by the teachers. Each teacher is responsible for a homeroom group (a teacher advisory group as they are called at Thomas Haney) composed of approximately 20 students, some from each of grades 8 to 12. In addition to these students for whom Beth is directly responsible, she also oversees and works with all students who are working their way through the learning guides for mathematics for grades 9 and 10. She marks these latter students' work and assists them one-to-one or in small groups.

I chose to write a journal for this course because looking back on my student teaching experience, the reflective journal we wrote during our practicum was most useful to me. I did not limit my entries to the readings and in-class experiences, but included some of my own teaching experiences during the past months.

The honesty and openness of the 12 students taking my course was a pleasure to behold. This was the fourth course the 9 students in the secondary mathematics masters program had taken together. They were pretty comfortable with one another. They quickly made the 3 new students welcome, and didn't even seem to mind too much that I was there prodding them to examine their own teaching and thinking! All were willing to expose the weaknesses they saw in their own teaching, and as with so many teachers, were reluctant at times to acknowledge that many things they did were creative and powerful for the pupils in their charge.

Hence, Beth's responses and analyses and reflections are fairly typical of all the students in the course.

October 10th, continued: I found Mary's [one of the two students Borasi worked with and about whom she wrote in her book] comments on their sessions especially relevant to my current teaching. Mary said:

I felt that, instead of having a teacher that was standing up in front of the room and dictating and saying, "No, you're wrong. Yes, you're right," it was more like, "Well, maybe, let's try it" (Borasi, 1992, p. 125).
This passage jumped out at me, for I thought (rather self-righteously), “This is what happens at my school, for I don’t stand up in front of the room and dictate.” But then, upon further reflection, I realized that even though it’s a smaller group of students, I did try to dictate. In the first week, when all students were on the same learning guide, I fell comfortably into routine of “giving” a lesson. Although I told the students that I would follow their lead and make their questions my top concern, I ended up doing a mini-lecture and then posing questions to check for understanding. I fell back into the role that I was used to and they remained in their student as receiver roles. It seemed that we both stayed with what was familiar.

About one week later, however, this approach was no longer possible. The nature of the system forced us to make changes as students began to spread out among several learning guides. If we, as a mathematics department, were going to stick with our original goal of offering discussion sessions at set times but not on set topics, then I would just have to change. I was not very comfortable with this change and was quite nervous as discussion session time approached every two days. Fortunately, both I and the students improved. I now feel quite comfortable with the notion that I have no idea what will be discussed ahead of time at our sessions.

This does not mean, however, that I have applied Raffaella’s style of “Well, maybe, let’s try it.” I still find myself saying, “No you’re wrong. Yes, you’re right,” quite often. Just because I am now directing this to smaller groups of students does not make me any less guilty of it. The students are helping me to change this style though. Because I do not work with all of the students in a session as one group, and, hence, ask the ones with whom I am not working to try to sort out some of their questions on their own, the students do get a fair chance to “just try it.” Recently I have often found that by the time I get back to the students who have been working on their own, they are intent on their own work. It feels like an intrusion if I ask them if I can help.

Initially I felt a bit hurt when they declined my offer of assistance. I realized, however, that I cannot hope my students will become independent learners and still want them to depend on me for help. Nonetheless I felt a bit rejected. My colleagues helped me by pointing out that what had happened should be seen as a very positive change. It is certainly true that the students have changed and I am often amazed at their ability to help themselves and each other to learn. They are applying Mary’s prescription for learning: “try to figure it out and ... make errors first. Which is a regular way of learning things: you make an error and you try to correct it and you just work it through.”

In the next two excerpts from Beth’s journal, she talks about our graduate class. I had offered the opportunity to all students in the class, as one tool of assessment for the course, to involve the rest of their classmates and myself in a mathematical learning experience. During the first few meetings of the class, I had done this on four or five occasions, and we had all found the experiences tremendously valuable for raising various issues about the teaching and learning of mathematics. I insisted that the experiences had to be real; that is, we weren’t to be asked to pretend that we were high school students and to then see how we would respond to that activity. The activity had to challenge us, with all our experience of teaching mathematics and with all our knowledge of mathematics itself. The next selections from her journal indicate the impact our class experiences had on Beth. They also indicate how Beth and her colleagues extrapolated some of these experiences to their teaching situations.

November 5th: Today in class, Devi brought in a tape for us to listen to. Albert Einstein’s comment about daydreaming struck me. The commentator said that by daydreaming, Einstein came up with some of his theories. I have often been frustrated with students getting off topic during my lesson. I can hear myself saying, “We have to concentrate on factoring today,” without giving the students a chance to pursue their thoughts. By seeing so many connections in mathematics recently, I know that a seemingly off-topic question in mathematics can quite possibly lead to some very interesting connections with the topic at hand.

Now, without having a class for which to plan, I have most often pursued the students’ questions. It doesn’t seem like such a risk as I am usually only working with only one or two students at a time and nothing is really off-topic, for it is the students themselves who provide the topic. I find that I enjoy discussing practically anything with the students, and I am seeing many more connections through these discussions.
November 11th: After reading Fisher's review of The Research Agenda Project, I began to think again about the assessment procedures we use at Thomas Haney. Unfortunately, as a department we have not spent much time thinking about assessment techniques used in our mathematics courses. The assessment we use has been more of a "quick fix" as there was no assessment guidelines included in the learning guides. I and others simply altered tests we had prepared in previous years to match the learning objectives for each guide.

A product-oriented assessment tool is being piloted in the math 11A course. The final exam in this course is a set of tasks, one for each of the main topics included in the course. Each task is quite detailed and involves much mathematical thought. For example, one question on the trigonometry section is, "Determine the height of the Great Hall." It is stated on the exam that the tasks may be done over an extended period of time. Also, students are allowed to get help from various sources as long as they are all referenced.

The Great Hall to which Beth refers is a huge open area, rectangular in shape, that runs the length of one wing of the Thomas Haney school. It is more than two stories high. It is where students spend much of their time working alone or with groups of other students.

November 11th, continued: The first student to hand in this exam did very well on some parts whereas others had to be improved. The teacher discussed the necessary revisions with the student during a half hour session which, in itself, was a good assessment procedure. I see this experience as a very positive direction for assessment in our math courses. I feel that it provides both the student and teacher with an insight into the student's mathematical abilities as well as a useful learning experience.

In the next excerpt, Beth once again reflects on an experience that occurred in our grad class. It revolves around the issue of teacher talk, and how productive, or not, it might be. Some wag once suggested that perhaps it is because teachers, when attending university to educate themselves as teachers, are talked at by university professors, endlessly it seems, that they seek their due by talking nonstop at pupils once they have a classroom of their own. Whatever the reason, Beth displays her openness and honesty as she confronts herself as she tries not to intervene unnecessarily when leading her colleagues in a mathematical experience.

November 19th: In class tonight, during our Tower of Hanoi experience, I played the role of presenter and observer. For me this proved to be a difficult task. I had looked forward to it, as almost every week I have participated in an experience and this time I would get a different perspective; I would have the opportunity to step back and watch others in action.

It turned out that I found it very hard to step back. I had to bite my tongue several times and, on some occasions, I did not succeed in shutting myself up. I wanted to help Sandy and the other graduate students, guiding them toward a solution. I found it nearly impossible to leave them alone and let them think, especially in the beginning if they had trouble getting started. I wanted to tell them exactly how to begin so that they would get going. Sometimes it seemed that they were doing nothing and, at those times, I longed to jump in!

I realize that this habit pertains to my own teaching, as I often jump in to help my students. I am now trying to stop myself, especially as I don't have the time constraint excuse (i.e., class will end soon so I'd better get them going) as much now at Thomas Haney. This experience helped me to be more aware of this aspect of my own teaching. It also relieved some of my anxiety as I saw that all the participants did work the problem out. They resolved it without my help and I think that perhaps backing off actually helped them, by allowing them to think it out. In fact Surjeet got annoyed when Kanwal and I did try to intervene and, in the end, I felt that they all had a good understanding of the patterns they had discovered. I do not always feel that my students have a good understanding of their work; maybe this is because I lead them a lot and they haven't internalized the understanding. That is, they may see how I can do it and each step may make sense, but they cannot do it themselves. I have to allow them to do it themselves. It's difficult for me to think that the assistance I offer may not actually help my students, but this experience has certainly made me think carefully about that very topic.

Another point I learned from this experience is that when I have an active role to play, I am better able to keep quiet. I realized this lesson when, during the second run through the experience, I had to be a recorder. As a recorder, I had a job to do and I could observe quietly as I was writing. I was observing with a specific purpose and the tension was reduced. I had...
less time to jump in since I was busy writing. I think this will help me with my students. If I make sure that I record or have something specific to look for in their work, I will be less likely to interrupt their thought process with my help.

It was a pleasant happenstance that the grad class had equal representation from each gender. Though I did not monitor the discussion on every occasion, during those times that I did do so it was clear that the women were not at all shy and retiring or inhibited about making their points of view known. Nor were the men reluctant to speak about their own affective responses to particular situations. Perhaps this was an unusual group. Perhaps over the 18 months that most of them had taken classes together, they had developed a level of camaraderie and trust that enabled them to speak of their own and others' struggles in teaching and learning mathematics. What is clear to me is that as a group they were sensitive to and aware of the challenges that face so many students, male and female, when studying mathematics. Moreover, interactions with pupils were not seen as just opportunities for the teacher to teach, but perhaps even more importantly as a chance for the teacher to learn. In the next, shortened excerpt, Beth talks about one of several female students she worked with as a consequence of her role as Teacher Advisor to more than just her own advisory group.

November 24th: I have enjoyed the opportunity I’ve had recently to work with girls who have felt very negatively toward mathematics. One particular example began last week when one of my colleagues came to me expressing concern over a girl named Aldona from her Teacher Advisor group. This girl has struggled in mathematics classes in the past and her frustration with math was continuing as she had not yet been successful with any of her learning guide tests. She moved on anyway and got even more confused as she was attempting to work on many different topics, feeling pressured to progress through the guides. Compounding Aldona’s problem was her fear of mathematics and her past failures as she was scared to ask for help, feeling sure that all of her questions were silly. Her TA asked me if I could meet with Aldona individually because Aldona did not feel comfortable asking for help in the group sessions. The TA also felt it was important for Aldona to connect with a female mathematics teacher.

I had the pleasure of working closely with Aldona this past week. I found her to be a thoughtful and creative student who strives to understand the concepts in her own way. I am fortunate because she will often say words such as, “Oh, you mean…” so I do not usually have to ask her to express her understanding of the concepts verbally.

This voluntary expression of her thought process has proven to be enlightening for me. She often sees things in quite a different way than I do and so my own understanding of some concepts has been enhanced. When I shared this experience with Aldona’s TA, she was delighted and said that Aldona seems much happier recently; in fact, she even received a note from Aldona at the end of one day excitedly reporting that she had just finished a math test! I, too, have noticed a difference in Aldona because she voluntarily comes to the kiosk to ask for help now, and we no longer have to set up individual tutoring times. She still does not come to the group sessions and often finds mathematics difficult and frustrating, but I am very pleased with the changes I’ve seen in one week. I am hopeful for Aldona’s mathematical future.

This type of communication is a welcome change for me. I now feel I can take the time to address the very important subject of feelings about mathematics. I did also pursue this previously, but always felt restricted to time after class or very short periods of time in between covering the curriculum during class. Now, at Thomas Haney I do not feel pressured to cover anything. I am concentrating much more on the students’ needs and addressing feelings of anxiety is a large need as I see it. As Jenny Maxwell (1989) writes in her Mathephobia article, mathematics is, unfortunately, often “a barrier to, rather than a means of, communication, which is not only about methods, hypotheses and answers but about feelings” (italics mine) (p. 225). I am seeing first-hand what a big role feelings about and attitudes toward mathematics play in students’ success with this subject.

There are those who at times despair of ever changing what they perceive as the sorry state of secondary school mathematics teaching. Certainly, reviews of the literature in the past few years do not paint a very complimentary picture of how mathematics is presented to secondary school students. But there are exceptions, and believe it or not, things do change. In her next excerpt, Beth gives us evidence that not only was there discussion with her graduate student colleagues regarding issues of, say, gender bias in the
teaching of mathematics, or of ethnomathematics, or historical aspects of mathematics, but such issues were beginning to be raised in her departmental meetings. After all, mathematics is above all else a very human enterprise!

December 4th: Another positive experience for me (on the subject of discussing feelings with students) took place at a recent departmental meeting when our department head brought up the topic of the affective side of mathematics. He and my other colleagues are concerned with promoting mathematics as a human endeavor in our school. It is very exciting for me to be working with others who have similar concerns. This year I am beginning to see possibilities to deal with some of these issues. Our department is starting to work together on a cross-grade program that will address some issues such as mathematics in society, women in math, and some cultural as well as historical aspects of mathematics. Although it was just one of the many goals we have set for our department, I left the meeting feeling excited about the future of the more human side of mathematics in our school.

In her book, Borasi (1992) argues that teachers should organize sessions which provide students with “occasions for reflecting on the significance of one’s inquiry” (p. 199). She suggests that students should reflect on the significance of their inquiries both while engaged in the investigation and after it has been completed. In my view, the latter is much more readily accomplished than is the former. Regardless, I do agree that being aware of what one is doing is the only way in which learning will occur. The additional step of being aware of oneself as one is learning is a challenge that requires working with students to help them develop tools for accomplishing this task. Beth’s final journal entry reinforces this point.

December 6th: I enjoyed reading the final chapter of Borasi’s book, especially the section on student reflection. I agree with her position on the positive effects of providing opportunities for students to reflect on their learning. From my own experience in this class, I realize that reflecting on mathematical activities is difficult at first but very worthwhile. It has provided much insight for me. Why not pass that opportunity on to my students? I thus want to incorporate this element into the math programs at Thomas Haney, but I feel it must be done carefully as I further agree with Borasi’s comment regarding the importance of providing structure to help students with their reflections.

No student learns in a vacuum, except perhaps in a university mathematics education classroom, and some of us are even trying to change that! Beth’s journal provides evidence that the concepts and ideas generated by students need to be tested for viability, and one sure way to do that is to bounce those ideas and concepts off of one’s colleagues. This can be done by discussion, by writing stories or keeping diaries, by large- and small-group presentations, by quiet one-on-one dialogue, but whatever the means, the important thing is for students to communicate with each other regarding the outcomes of their mathematical investigations. This is what 12 graduate students and I tried to do in my course last fall.

How are you doing in the courses you teach?

References


Beth Mehrassa obtained her teacher education through Simon Fraser University’s Professional Development Program. She has taught for four years in Maple Ridge, a suburb of Vancouver, BC, Canada. Beth is currently enrolled in SFU’s Master’s Program for secondary school mathematics teachers.

Sandy Dawson is an associate professor of mathematics education at Simon Fraser University, and director of that institution’s teacher education program. His most recent research interests center on the areas of LEGO/Logo and the exploration of what mathematics lessons with a constructivist or humanistic focus might look like.

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Fourth-grader Kevin started, as many other students do, by building a car out of LEGO (Resnick, 1988). After racing the car, he added a motor. The car moved forward a bit... and then the motor fell off and vibrated across the table.

The movement interested Kevin. He wondered if he could use the vibrations to power the vehicle. He mounted the motor on a platform of LEGO axles. Experimentation taught him that he needed some way to amplify the vibrations. Building on his skateboarding experience, he created a swinging arm. As the gear turned, the arm whipped around—and amplified the motor vibrations. Indeed, the amplification often tipped the walker over, and he took a friend’s advice and attached tires horizontally at the bottom. He could control the walker—it turned right when the motor rotated in one direction, left when it rotated in the other.

Kevin eventually made the walker follow a black line by attaching a LEGO sensor to it. He wrote code similar to the following (rewritten a bit for readability).

```logo
to follow
  look-for-line
  go-past-line
  reverse-direction
  follow
end

to look-for-line
  waituntil [floor-color = "black"]
end

to go-past-line
  waituntil [floor-color = "white"]
end

to floor-color
  if sensor? [output "black"]
  if not sensor? [output "white"]
end
```

The researchers claim that Kevin learned specific engineering concepts, an appreciation for both the constructive uses and destructive potential of vibration in mechanical systems, and basic ideas about feedback and control. Most important, he gained a sense of process of design.

**Research on LEGO-Logo**

With its lights, sensors, motors, gears, and pulleys, LEGO-Logo is a unique new member of the Logo family. Designed to offer students the opportunity to invent meaningful constructions in their classrooms, LEGO-Logo provides a more motivating context for exploring science ideas. Researchers have conducted only a few studies, but they provide an initial glimpse at learning with LEGO-Logo.

**Bolstering Achievement and Investigative Processes**

Only a few studies have measured student achievement in relation to the use of LEGO-Logo. In one of those studies, fourth-grade students made small but important gains mathematical achievement (Browning, 1991). They improved the most on items related to angle concepts. For example, only 3 of 22 students in a fourth-grade class entered a response that resembled an angle when asked to draw a right angle. On the posttest, 17 drew the angle adequately.

In another study (Flake, 1990), one fourth- and one fifth-grade class worked with LEGO-Logo, while another fourth- and fifth-grade class studied the same curriculum without LEGO-Logo. The LEGO-Logo classes increased more in math achievement in both concepts and problem solving, although the control group experienced higher gains in computation.

Weir (1992) also reported gains in mathematics achievement, especially on tasks requiring higher-order thinking. As one example, one boy, Peter, was playing with his LEGO-Logo car and the procedures he wrote, WIGRT (wiggle-to-the-right) and WIGLT. He had typed REPEAT 10 [WIGRT WIGLT]. Then, having already explored the SETEVEN command (which sets the motor in an even, or forward, direction), he realized that programming can create alternating evens, and that odd-even distinctions can be used. This leads to the following investigation.

**Interviewer:** So where does it end up?

**Peter:** Right back where it started! That’s because I chose an even number.

Peter tries an odd number, but it still ends up where it started. He thinks, and then types, REPEAT 9 [WIGRT WIGLT WIGRT]. All are delighted with the result.

The notion of reversibility apparently became a real tool for Peter. One day, a wire became stuck in a worm gear. An adult reached out to try and untangle it physically. Peter stopped him and used the computer...
to reverse the direction of the motor, smiling as the wired gracefully unwound.

Weir (1992) asserted that both LEGO and Logo help "decontextualize" concrete experiences, letting them become more generalized and abstract. She also claimed that LEGO-Logo supports higher-order processes, such as debugging, and invites creativity. Of course, teachers must help make this happen. The researcher/teachers found they were often successful when they used fewer verbal descriptions and instead adopted a participatory, "let's do it with LEGO-Logo," approach.

Finally, using LEGO-Logo did not substantially change a fourth- and fifth-grade class' science-like behavior (Dawson & Bell, 1991). A separate fifth-grade class increased in both science-like behavior and inventor-like behaviors, while a split sixth- and seventh-grade class increased in science-like, but not inventor-like, behaviors.

Overall, then, results with LEGO-Logo are similar to those with Logo: there are mixed results, generally with small but significant gains in achievement. It is promising to see some measure of different kinds of achievement, especially in problem solving and in processes.

**Supporting Large, Complex Tasks**

A study of a fourth-grade class in an Apple Classroom of Tomorrow revealed that immediate access to computer technology, including LEGO-Logo and writing plays using the computer program Showtime, supported teachers' implementation of tasks that were larger, more complex, and more open-ended than usual classroom tasks (Fisher, 1990/91). (Tasks were rated on characteristics such as task size and cognitive complexity. On both characteristics, handwriting instruction was rated 1 and LEGO-Logo was rated 4 on a 5-point scale.) Students had to make more decisions, and different kinds of decisions, as they worked on these larger tasks. This in turn helped them become more active and independent learners.

The effect on students' autonomy and empowerment varied to the extent that they caused, controlled, or influenced the content, process, product, and evaluation of their own learning. LEGO-Logo was especially high in this regard (compared to Showtime). Why? With LEGO-Logo, students made decisions about the product they were to build and the processes they would use to build and test models. These were to be working models of some real-world mechanism or situation. They included a car wash, a basketball court, a jumbo jet, and a house in which the lights came on when the door opened. Team members took individual roles, including builders, programmers, and recorders.

What role do computers play? They help minimize the problems involved in managing more complex tasks. The high-access computers help "absorb" more student variation before the classroom management problems become overwhelming. Also, larger tasks can be more easily supported with technology than with noncomputer materials.

**Increasing Motivation and Self-Esteem**

LEGO-Logo appears to motivate students. In two studies of fourth-grade students, attitudes were positive and motivation increased in comparison to other classroom tasks (Browning, 1991; Fisher, 1990/91). There is some evidence that interaction with LEGO-Logo may develop self-esteem (Weir, 1992). This may be because LEGO-Logo provides an academic setting in which students can develop their own goals.

Other researchers report increased empowerment with LEGO-Logo, especially among underachievers (Silverman, 1990). In Flake's (1990) study, one boy who had performed poorly in math in the past became enthralled with LEGO-Logo and completed a fairly complicated project, much to the surprise of his teacher.

**Affecting Social Interaction**

Some of these studies also reported beneficial small-group interactions as an outcome of LEGO-Logo work. However, not all studies with fourth-graders have been positive. In one, some fourth- and fifth-grade groups got along, but others broke up. Generally, the students performed poorly in groups and did not improve over time (Dawson & Bell, 1991). The group behavior of students in higher grades seemed to improve with LEGO-Logo work. Dawson and Bell then concentrated their work on students in grades 5-7. Teachers and students believed that students learned to work cooperatively with LEGO-Logo, although the students did not believe that the work in groups improved. Teachers and students agreed that six students were too many for one group.

When the researchers asked teachers to compare the two years, they believed that they provided more structure for the students, gave them more challenges, and pushed them more. The students agreed that the second year was more challenging, but they also believed it was more interesting and better organized. More adequate supplies of equipment were also beneficial. Such insights argue that we need research from teachers.

Like Logo, LEGO-Logo is the kind of innovation that might best be studied by dedicated teacher-researchers, possibly in collaboration with other researchers.

**References**


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Preparing Teachers to Do Logo Research

An infusion of federal money in the past three years has enabled the schools of the United States Virgin Islands to receive much in the way of computer equipment and software. The University of the Virgin Islands has been offering graduate-level courses leading to a master's degree in computers and technology in education. More than 300 Caribbean teachers have enrolled in these courses over the past two years. In the summer of 1989, Glen Bull, Tom Lough, George Uhlig, Mary Ann Gillis, and Bulgaria's Iliana Nikolova came to the Virgin Islands to deliver an intensive three-week Logo workshop attended by 40 teachers.

This column will focus on steps taken to prepare teachers to do Logo research and will specifically discuss research conducted by three teachers in the Virgin Islands. One of these involved six low-achieving fifth graders, another involved a group of high school computer programming students, and the third involved a group of kindergartners.

Preparation for the Studies

A major criticism of Logo research is that the researchers have had little experience with Logo (or any other programming language), using computers with children in a classroom, or research methodology (Moursund, 1983/84; Leousis, 1985). The three researchers conducting the studies described below methodically prepared for their research by:

- taking an extensive three-week workshop
- taking five semester-long courses in computers and technology in education
- taking two courses on research methods and statistics
- conducting an extensive search of the literature related to their study
- conducting classes using Logo

Each of these five preparatory events is discussed in more detail below.
students in the Virgin Islands and with an overseas class, producing an educational video tape, developing a substantial HyperCard stack, producing a document using desktop publishing and collecting data on hardware available in Virgin Islands schools.

Research Courses

In addition to the above Computers in Education courses, each researcher completed two semesters of research methods and statistics. These are standard graduate-level courses that required each participant to conduct small research studies as part of the course curriculum.

Familiarity With the Literature

Each researcher did a substantial search of the literature related to his or her study. A free Dialog account was given to each researcher. In addition, the researchers contacted experts in the field, such as Douglas Clements, Tom Lough, Dave Moursund, and Glen Bull. My own extensive Logo library was also available to the researchers.

Teaching Experience

Each researcher taught a group of students Logo and LEGO/Logo before conducting his or her study. As part of the masters program at the University of the Virgin Islands, groups of youngsters were brought to the university on eight consecutive Saturdays for graduate students to teach Logo and LEGO/Logo. These sessions lasted for two hours each. Graduate students were matched with six to eight children whose ages matched those they would be teaching in the public schools.

The Studies

The five areas of preparation described above provide a reasonable background for a teacher to conduct research in the classroom use of Logo. The results of each of the three studies (a high school study, a middle school study, and a kindergarten study) will now be described and examined. Each of the following three sections will give a brief background of the students involved, the hypotheses being tested, research results, and any conclusions the researchers arrived at.

High School Study

This study was conducted by Lennox Douglas (Douglas, 1990). Mr. Douglas is an educator from the Caribbean country of St. Kitts/Nevis.

Douglas (1990) hypothesized that:

1. there would be no significant difference in the amount of computer knowledge acquired
2. there would be no difference in students' attitudes toward either computers or learning of students taking Logo, Pascal, or BASIC programming in secondary school

Mr. Douglas wanted to investigate the effects of learning a particular computer programming language and how it affects:

- students' attitudes toward school
- students' attitudes toward computers
- the general computer knowledge of students in three different secondary-level computer literacy classes.

The sample consisted of 11th- and 12th-grade students from three separate required computer literacy classes (Computer I) in a secondary school in St. Thomas, U.S. Virgin Islands. The students were arbitrarily placed in each class by the principal. Each class was randomly assigned to one of the three conditions: Logo, Pascal, or BASIC programming. The Logo group consisted of 19 students, while the BASIC and Pascal groups consisted of 10 students each. Although the sample size was small and the use of descriptive statistics in Logo research is now rare, Douglas' extensive preparation and teaching background along with the aforementioned preparation make his conclusions and recommendations meaningful to teachers using Logo.

Statistical analyses were done on scores from pretests, midtests, and posttests to determine any significant differences within and between groups. The results showed no significant differences between any of the groups. Hence, in these cases, it was concluded that exposure to the treatments (Logo, BASIC, or Pascal) did not have any significant effect on students' attitudes toward school with one group relative to the other. These results seem to verify the hypothesis that there is no significant difference in the three groups' attitudes toward either computers or learning.

On the other hand, results revealed some significant differences within the groups (from pre-, mid-, and posttest differences). There was a significant decrease in the Pascal students' excitement about the computer class from pretest to posttest. These attitudinal changes toward school could be attributed to the fact that students viewed Pascal as being much more difficult than Logo or BASIC (Teacher's Diary). The students in the Pascal class had greater fears than did Logo or BASIC students that the class would be difficult, and, hence, they felt less excited about taking programming.

On average, the BASIC students indicated having more problems writing programs in BASIC than did the students in Logo or Pascal. This is a possible reason why students in the BASIC class seemed to undergo greater stress in learning than did the students in the Logo or Pascal class. The Logo students had a signifi-
cant increase in their belief that they had used the computer much more after the midtest. It was only the ratings given by students of the BASIC class that showed no significant differences in their beliefs that they used the computer very much after any of the two treatments. This is consistent with the fact that they viewed BASIC programming as difficult (Diaries), and seemed to be less motivated once the programming classes got under way.

After the programming treatment, the Pascal group was the only group that showed a significant increase in their belief that they could learn to use the computer quickly. The fact that they generally had the preconceived notion that Pascal was more difficult than Logo or BASIC and the fact that “they had learned to program in Pascal” suggest that they might have seen this accomplishment as being much greater than the other two groups perceived their learning to be. Hence, they believed they could learn to use the computer more quickly.

One of the main objectives of this study was to compare the general knowledge of students after each treatment. Results show that there were no significant differences between any of the groups on the pretest or midtest. This indicates that the groups were homogeneous and began the study with similar knowledge. On the other hand, the significance level between the two sets of scores for the BASIC posttest and the Pascal posttest indicate that there is a 96% chance that Hypothesis 1 is correct (there would be a significant difference between the knowledge levels of both classes after each class learned programming in two different programming languages). Hence, the null-hypothesis was rejected, and it was concluded that learning to program a computer with a particular programming language will affect students’ computer learning in a way that might be different from learning to program using another programming language. In this particular case, these findings revealed that the Pascal students learned more than the students in the BASIC class, having undergone different treatments under similar conditions. Hence, it is likely that students in a Pascal class may learn more than students in a BASIC class who undergo similar treatments. The BASIC group is the only group that did not learn significantly more from the programming treatment. The study tends to suggest therefore, that discrepancies may be raised about using BASIC to teach programming in preference to Logo or Pascal.

These results had implications on which computer language was used in the schools of the Virgin Islands. Pascal and Logo are now being promoted in the territory. Of course, there are some apparent problems. Each language was designed for very specific and very different ends. For example, for a sorting operation, Pascal wins hands down. Attempt to “speed” program and BASIC wins. Try to introduce structure in programming (without writing to files) and Logo wins. With file writing, Pascal wins. Mr. Douglas concluded that the controversy concerning which programming language should be used to teach programming in the schools will continue until there is substantive evidence that students will learn more by using one language than by using another.

Middle School Study

This study was conducted by Canadian teacher/researcher Nancy Silverman (Silverman, 1990). Her sample consisted of four sixth-grade students who were classified in the Virgin Islands as being underachievers; all the grades of each student were below C-in each course taken the previous semester. The four students met after school in the computer laboratory for 25 sessions lasting 45 to 60 minutes each.

The purpose of the study was twofold:

1. Could these underachieving middle school students learn to program using Logo?
2. Could an extracurricular course of this nature increase the students’ feelings of empowerment by increasing their self-esteem, self-confidence, and social skills?

A Logo hierarchy (checklist), along with the students’ daily diaries, was used to answer the first question. The teacher’s diary, student diaries and questionnaires given to the students’ subject-area teachers and their parents were used to make conclusions regarding the second question.

Two students were able to master all nine skills of the hierarchy. One student could not do skill 7, while one student could not do skills 4, 5, 6, and 7. Subject-area teachers were pleased with the way all four students were achieving in class. All four students’ conduct, attendance rate, and grades improved during the subsequent semester. The classroom teachers also noted that the students related better to both their peers and teachers. Ms. Silverman concluded that these positive results were due to the Logo classes, which provided a success experience that changed the way the students thought about themselves.

One problem noted by the researcher was that the children did not want to stop using the computer to fill out their diaries. She felt that if the diaries were done on-line, the students would be more enthusiastic about completing them.

Because of the positive results of this research, many teachers at Ms. Silverman’s school have enrolled in the graduate-level Logo courses. A videotape taken during the study was produced, which showed “learning-disabled students” using Logo. This tape has been
distributed to 30 schools in the Virgin Islands, and Ms. Silverman has expanded the program to reach more students in her own school.

Kindergarten Study
This study was conducted by Lucinda Parsons, a kindergarten teacher on the island of St. John. This study involved four kindergarten students not in her class and unfamiliar with Logo. Ms. Parsons tested two hypotheses:

1. Logo can help provide a learning environment for kindergarten students that will encourage peer interaction and cooperative learning.
2. A marked increase in attention span (time on-task) will take place over time as a result of using Logo.

To test these hypotheses, the researcher bought in a two pair of students for a one-hour period and videotaped the Logo learning session. Fifteen sessions were delivered to the four students. Analysis of the videotape provided data relevant to the two hypotheses.

A stop watch was used to collect data. The amount of time the children worked alone, talked to others, listened to teachers, and so forth was graphed over time to see if cooperative learning increased. The amount of time on-task for each student was plotted over time to see if this variable increased over time. In addition, observations that may be of interest to other primary school teachers was noted from the tapes. Ms. Parsons is well aware that some educators feel that the earliest a student should use Logo is the third grade, but having worked with kindergartners for two semesters, she is very much interested in whether positive benefits can occur.

Final results did indicate that both time on-task and peer interaction increased with these kindergarten students.

Conclusions
The three studies from the Virgin Islands summarized above took special care to prepare the researchers for their studies. Much of the criticism aimed at Logo research has been that the studies were conducted quickly by university graduate students. These three studies evolved over a three-year period and were completed by experienced classroom teachers.

The three studies involved both qualitative (observational) and quantitative data. Only one of the studies made conclusions based on the central tendencies of learning outcomes because two of the studies involved only four subjects. There has been some question as to whether measures of central tendencies is possible in Logo or any new educational philosophy (Haber, 1985; Papert, 1985). Based on the results of the Douglas study, something can be said for quantitative studies because the statistics gathered accounted for the fact that it is impossible to keep everything the same except Logo and that a teacher cannot expect to see the same changes in all students as a result of being exposed to Logo.

There has been much recent concern in the Virgin Islands about low mathematics test scores. These three studies have pointed out to curriculum planners that Logo can be beneficial in developing higher-order thinking skills that are not necessarily going to show up on standardized tests. The school superintendent is now encouraging other teachers to develop the skills necessary to use Logo in their classrooms.

David Moursund (1983/84) asked, “Is it fair or possible that Logo be evaluated with ordinary teachers—those with modest levels of training, experience, and interest in Logo?” The answer is probably “no,” seeing that, for example, an art teacher or a reading teacher would have the interest and expertise when conducting his or her classes. That is why such special care was taken to provide the needed background and motivation to make these three studies as valid as possible.

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