THE USE OF LOGO IN PRE-SERVICE MATHEMATICS TEACHER COURSES

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Herein we describe our use of the public domain software MSWLogo™ in two mathematics courses for pre-service teachers. One course, MATH 3370, is required of all students preparing to teach in elementary school, and the other, MATH 4371, is for students preparing to be middle school mathematics teachers. First we present a brief description of these two courses. We then discuss our rationale for using MSWLogo™ in these two courses and provide examples of the logo materials we use.

MATH 3370 is called Elementary Geometry. It is the third course in a three course mathematics sequence required of all students preparing at our university to teach K-4, as well as those students seeking certification as a Middle School Mathematics Specialist. A detailed description of the original creation and implementation of this mathematics sequence, and a more recent review of it progress from its inception in 1994 through 2003 are available in the literature. [Harris, Tarwater 1997 and Harris, Schovanec 2004] Let it suffice here to say that the main focus for the content of MATH 3370 is topics from Euclidean Geometry that are of particular relevance to elementary and middle school teachers, and the emphasis of the pedagogy is on student centered learning with lots of group activities and use of manipulatives. Logo enters the course in the form of group activities done in the computer lab using the locally developed materials described below.

MATH 4371 is called Basic Computer Literacy and Programming. It is a capstone mathematics course covering topics from arithmetic, number theory, algebra, coordinate geometry, and elementary calculus in the context of the computer algebra system MAPLE. Several articles dealing with various aspects of MATH 4371 appear elsewhere in the literature. [Harris 1996, Harris and Schovanec 1997, Harris 2001] . Logo is used as the vehicle for introducing the students to programming as described below. It is the last thing done in the course and accounts for about 20 percent of the total time for the course.

Our rationale for using Logo is summarized in the following sequence of bullets.

- It is very easy to get started using Logo.
- Logo promotes logical, organized thinking.
- Logo promotes understanding of basic concepts from elementary geometry.
- Logo is very interactive.
- Logo provides instant gratification.

- Logo has unlimited potential.
- Students really enjoy learning and using Logo.
- Logo is free public domain software. [http://el.media.mit.edu/logo-foundation/]

The remainder of this paper consists of sample exerts from the Logo materials we developed for these two courses. It is hoped that a review of these examples will provide some support for the above assertions.

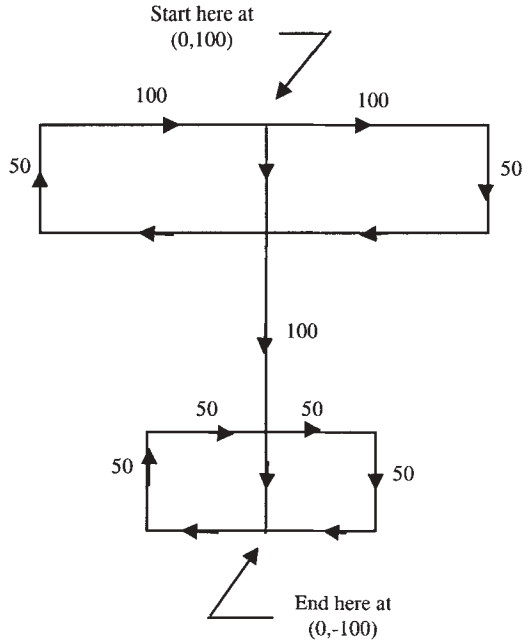
Our Logo materials consist of a series of worksheets (in WORD format) divided into three chapters: Introduction to Drawing with Logo, Elementary Programming with Logo, and Recursion in Logo. Only the first chapter is used in MATH 3370. All three chapters are used in MATH 4371. The ease of use and interactive nature of Logo can be seen in the following introduction of the first chapter. Students are shown how to load Logo and given the following instructions.

> Commands are entered on the bottom line of the "Commander" window and recorded in the top portion of the window. The effect of the commands is seen in the full MWSLogo screen. Try the command **HT** (Enter) and see what happens.
>
> The little triangle (wedge, or pointer if you wish) is called the turtle. Its home is the center of the graphics window facing due north (up). Now try the command **ST.** The "S" stands for "show", what do you think the "**T**" stands for?
> What do you think **HT** might stand for?
>
> Think of the turtle crawling around the screen with an ink pen attached to its tail and experiment with each of the following command sequences in the commander window. Pressing the return key produces the corresponding effects. In each case below describe the effect produced by the command sequence and state what you think the command is an abbreviation for. **Note the spacing is important!**
>
> (If you draw a line you don't want, try erasing it with the command **PE,** pen erase, followed by reversing the command that drew the line in the first place. Of course after doing this you must turn the pen back to the drawing position before any more lines can be drawn. The command for doing this is **PPT**, pen paint.)

FD 100	
RT 90	
FD 100	
HOME	

LT 90	

The students are supposed to enter their responses in the appropriate places on the WORD document. Through such guided experimentation the students, in effect, are expected to create their own Logo syntax manual. The exercises continue in this vane throughout the first chapter. Quickly students are able to complete the following exercise: In the table provided fill in the sequence of commands to draw the following picture with no line being traced more than once.



The exercises continue with the students learning the syntax for performing standard arithmetic operations and trigonometry, and the students learn how to use the PEPEAT command to draw all regular polygons. For example, the command repeat 10[fd 50 rt 360/10] produces a 10 sided regular polygon, with each side length being 50 units. The chapter, and hence the Logo experience of the 3370 students, ends by asking the students to complete the following command sequence to draw a right triangle in general position:

FD 100 RT 90 FD 130
RT
FD

The solution is as follows:

```
FD 100 RT 90 FD 130
RT 180-ARCTAN 100/130
FD SQRT ((POWER 100 2)+(POWER 130 2))
```

The 4371 students continue into the next chapter learning how to create and save Logo procedures (programs) that can take variable input. For example the command sequence

```
TO TRIANGLE :A :B
FD :A RT 90 FD :B
RT 180-ARCTAN :A/:B
FD SQRT ((POWER :A 2)+(POWER :B 2))
END
```

creates a command invoked by the word TRIANGLE which produces a right triangle with side lengths :A and :B. Students are asked to create and save programs for drawing regular n-sided polygons with side length L, n-pointed regular stars with side length L, and assorted other shapes and patterns. In the final chapter these students are introduced to recursion and create programs like the following for drawing all regular polygons from :N sides to :M sides, each with side length :L

```
TO LIMPOLY :L :N :M
IF :N>:M [STOP]
REPEAT :N[FD :L RT 360/:N]
LIMPOLY :L :N+1 :M
END
```

The Logo portion of 4371 concludes with the students working in teams of 2 or 3 to complete the following "Final Project"

> Write and save a program that draws a scene of a school house on a starry night with nice landscaping and a crescent moon. (A picket fence with a gate to the back yard playground would be nice, wouldn't it?) Don't forget to put the names of your group members somewhere on your picture. Include both the picture and your program for drawing it in your portfolio.

The program for building the crescent moon is one of the more challenging exercises for most students. Students are advised to create subprograms for constructing various pieces of the picture; for example, a program called HOUSE for constructing the building, SKY for constructing the sky, FENCE for building the fence, etc. The final program called PROJECT should consist of a list of 5 to 10 words. While there are always a few teams who pursue a path of least resistance, producing the most minimalist picture possible satisfying the directions, most teams get into their projects by adding all kinds of details such as flags, trees, playground equipment, and color.

And there are always several groups who really get carried away, composing music for their projects or experimenting with 3-dimensional effects and animation. Others have gone to the web to find fractal programs for making willow trees.

In summary, we believe LOGO provides an excellent tool for helping the pre-service elementary and middle school teachers enhance their understanding of basic geometric concepts involving shapes and patterns. It allows them to develop their reasoning and organizational skills in a non-threatening environment that can even be entertaining. It offers them the chance to be imaginative and creative in a mathematics class. And it introduces them to a tool they might be able to use in their own elementary and middle school classrooms.

References

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