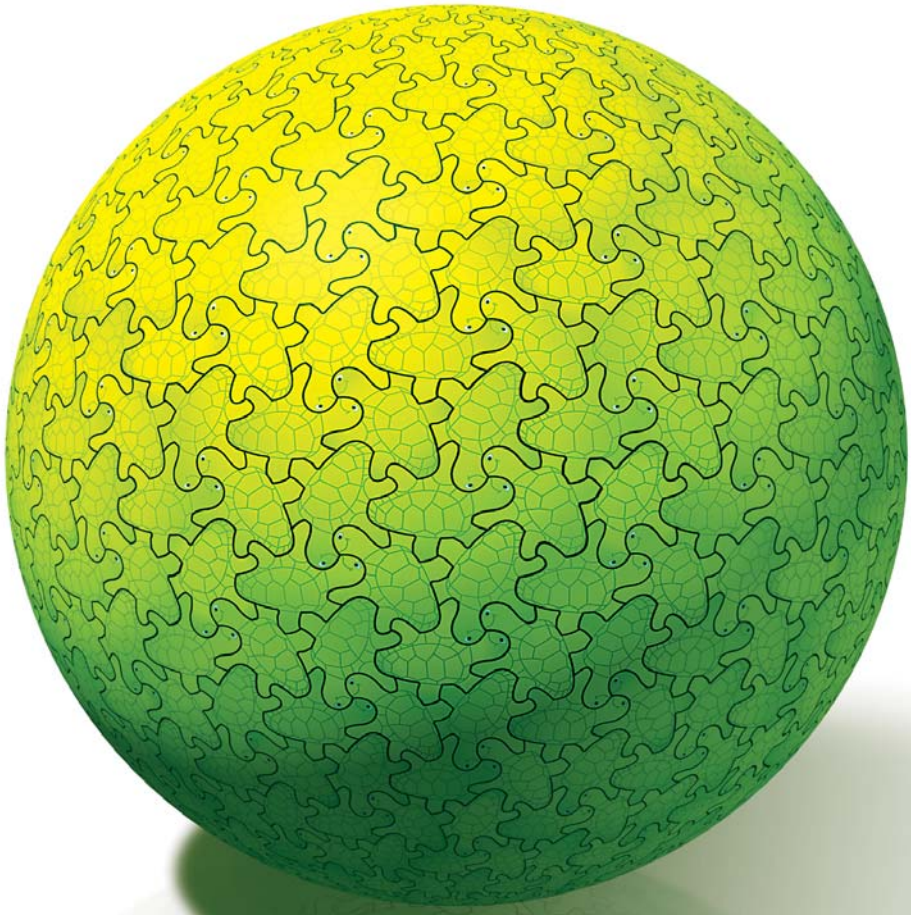

EXPLORING MATH WITH MicroWorlds EX™

By Wendy Petti

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Introduction

Let's dream for a minute. Imagine you teach math in a classroom where students take charge of their own learning in creative ways… and their math skills and understandings develop at the same time. Imagine computers equipped with software that takes students far beyond skill practice and even beyond conceptual understanding… to a world in which students explore and apply their skills and understandings as they teach the computer to do new things.

Would you rather imagine a math classroom in which math standards are posted, the teacher guides each lesson, and assessments ensure that students are achieving the lesson objectives?

With MicroWorlds EX, both are possible. In fact, that's what MicroWorlds is all about.

This book and companion CD, teamed with MicroWorlds EX, can help you realize either or both visions. This book contains a collection of math activities that address big ideas along with practicalities. These activities have been designed for students in grades 4 - 7, but they can be adapted for older or younger students. These activities will help you use MicroWorlds EX to support the math curriculum in meaningful, dynamic, flexible ways.

This book assumes that you may be learning along with your students. For some teachers, that might raise concerns: “My students and I are so busy already - how can we make time for learning new computer skills along with math skills? I don't know a thing about MicroWorlds or programming! How can I teach something when I'm just learning it myself? What will my students think if I don't know the answers to all their questions? What if an activity doesn't work and I don't know how to troubleshoot it? How can I teach my students to use this software if I only have a couple of computers in my classroom - do I need to take the whole class to a lab? How can I help them all at once? And why should I bother with any of this when my students could play a computer math game much more easily?”

This book has been written with these concerns in mind. They are specifically addressed in the “Classroom Environment” section beginning on page 11. Relax, keep an open mind, and read on!

WHAT IS MICROWORLDS EX, AND HOW CAN IT HELP ME IN THE MATH CLASSROOM?

MicroWorlds EX is a multimedia learning environment in which you and your students can explore, visualize, and analyze ideas. It is a collection of tools, and it is a language

The Language of Math and MicroWorlds

Let's look at both the language of mathematics and the language of MicroWorlds.

Young children begin learning the language of mathematics informally at home, starting with counting. In school they begin to learn the formal language of mathematics as they learn how to represent familiar ideas in new ways. They learn to translate English into math and math into English:

English: `"I've taken 5 steps, and now I'm taking 3 more steps. 6, 7, 8 - that makes 8 in all."`

Math: `5 + 3 = 8`

The language of mathematics has a vocabulary, rules, and grammar. This language helps us communicate mathematical ideas clearly and efficiently. Students learn the language of mathematics gradually as they develop new conceptual understandings.

MicroWorlds EX is built on the Logo programming language. This language also has a vocabulary, rules, and grammar for communicating with the computer clearly and efficiently. You do not need to know or understand the Logo language to begin using MicroWorlds in powerful ways, and this book does not aim to turn you into a programmer. Just as children begin to learn and understand the language of mathematics in the context of real world situations, this book will gently introduce you and your students to a little bit of the Logo programming language, as needed, so you'll be able to explore mathematical ideas in exciting new ways.

Sometimes the language of Logo in MicroWorlds EX matches the language of math. If we type 5 + 3, the computer knows this equals 8. (But if we type 5+3, we'll get an error message, for in the rules of grammar of MicroWorlds EX Logo, we must put a space between each number and operation.)

Sometimes the language of Logo sounds rather like a shorthand version of English. For instance:

hidetext means, "Make this textbox invisible."

if colorunder = 45 [ht] means, "If the number of the color underneath this turtle is 45 on the built-in color chart (orange) then hide the turtle."

The activities in this book deliver big results with a few simple lines of programming code, along with a clear English "translation."

My students and I are so busy already - how can we make time for learning new computer skills along with math skills?

The Technology Principle in NCTM's *Principles and Standards for School Mathematics* speaks eloquently about the importance and value of technology in the math classroom:

In the mathematics classrooms envisioned in *Principles and Standards*, every student has access to technology to facilitate his or her mathematics learning under the guidance of a skillful teacher…

> Technology enhances mathematics learning… Students' engagement with, and ownership of, abstract mathematical ideas can be fostered through technology. Technology enriches the range and quality of investigations by providing a means of viewing mathematical ideas from multiple perspectives. Students' learning is assisted by feedback, which technology can supply… Technology also provides a focus as students discuss with one another and with their teacher the objects on the screen and the effects of the various dynamic transformations that technology allows… Students who have trouble with basic procedures can develop and demonstrate other mathematical understandings, which in turn can eventually help them learn the procedures…
>
> Work with virtual manipulatives (computer simulations of physical manipulatives) or with Logo can allow young children to extend physical experience and to develop an initial understanding of sophisticated ideas like the use of algorithms.

Principles and Standards for School Mathematics
National Council of Teachers of Mathematics (NCTM): http://nctm.org/standards

The activities in this book help support and enhance students' understandings of important math concepts and skills, as envisioned in NCTM's Technology Principle and in the Curriculum, Teaching, and Learning Principles. Many of the activities help students look at familiar math in new and meaningful ways. This is math time well spent. The new computer skills and analytical skills learned along the way are a wonderful bonus.

Coordinate-d Symmetry

TEACHER NOTES

OBJECTIVES

Use coordinates to draw a geometric design or shape with two lines of symmetry.

CONTENT STANDARDS ADDRESSED

- GEOMETRY
  - use coordinate geometry to represent and examine the properties of geometric shapes
  - use coordinate geometry to examine special geometric shapes
- NUMBER AND OPERATION
  - explore numbers less than 0

Duration: 1 - 2 class periods

BEFORE YOU START

- Students should work through *Connect the Dots Coordinates-Style* first. Familiarity with *Shape Up with Coordinates* would be helpful.

NEW MICROWORLDS EX TERMS AND SKILLS

Skills:

- multiplying by -1 to get an inverse
- using a textbox to hold data
- addressing a specific turtle or textbox

Terms: everyone, list, print pos, ct, *

RELATED EXPLORATIONS

- The "Symmetrical Butterfly" math craft can be adapted to geometrical designs:

  http://www.mathcats.com/crafts/symbutterflies.html
  Students can create a hands-on design first with two lines of symmetry and then try to replicate it using this MicroWorlds EX activity.

TO THINK ABOUT AND DISCUSS

- Students may want to draw the x-axis and y-axis on the Wallpaper page, as they did in the *Connect the Dots Coordinates-Style* and *Shape Up With Coordinates* activities. They can also set each turtle to a different color to see how their positions change, especially when the xpos and ypos sliders are set to negative values.
- See the "Think About It" questions at the end of the student activity.

Coordinate-d Symmetry

PLAY FOLLOW THE SLIDER

AS YOU GENERATE AMAZING

MIRROR-IMAGE DESIGNS!

GOAL

Use coordinates to draw a geometric design or shape with two lines of symmetry.

PLAN

Here's what you'll do in this activity:

- To set up the activity:
  - Use two sliders to set the x and y coordinates of a drawing turtle, and write a simple **go** procedure to steer this turtle using the slider coordinates. Create a *go* button and practice steering the turtle to draw a shape, alternating between moving the sliders and pressing the button. Then add a text box to keep track of the turtle's coordinates as it moves.
  - Create a second turtle to draw a mirror image of everything the first turtle does, multiplying the value of the first slider by -1. Create a second text box to keep track of the second turtle's moves.
  - Add two more turtles to draw mirror images of the first two turtles, multiplying the sliders by -1 as needed, and add two more text boxes to keep track of their moves.
  - Write a **reset** procedure to move all of the turtles home and clear the contents of the text boxes. Add buttons to make it easy to put the turtles' pens up and down.
- To use the activity:
  - Explore drawing symmetrical designs in an open-ended way.

Multiple Patterns

TEACHER NOTES

OBJECTIVES

Stamp colored marks at regular intervals representing multiples of different numbers in order to analyze these multiples by comparing the different patterns they generate.

CONTENT STANDARDS ADDRESSED

- NUMBER AND OPERATION
  - develop fluency in adding, subtracting, multiplying, and dividing whole numbers
  - use factors, multiples, prime factorization, and relatively prime numbers to solve problems
- ALGEBRA
  - describe, extend, and make generalizations about geometric and numeric patterns
  - develop an initial conceptual understanding of different uses of variables

Duration: 1 - 2 class periods

BEFORE YOU START

- Students should be familiar with writing procedures (introduced in both the *Wiggles activity* and in the *Turtles and Geometry* tutorial in the original set of MicroWorlds EX Tutorials).

NEW MICROWORLDS EX TERMS AND SKILLS

Skills:

- creating shapes in the turtle's backpack
- writing turtle rules
- programming a color
- freeze a page background

Terms: seth (setheading), everyone, clickon, stamp, setx, clean

RELATED EXPLORATIONS

- Place objects on a hundred square or along a number line (such as a meter stick) for a hands-on visual representation of common multiples. For instance, place toothpicks along the number line, using a different color to mark the multiples of each of two numbers in order to find the common multiples.
- Use a metronome to set a steady rapid beat. If you are comparing the multiples of 3 and 4, have one student clap on every third beat while another student claps on every fourth beat as other students listen to the combined rhythm. When both students clap at once, they've reached a common multiple.
- Phil Tulsa's online "Unifix Drum Machine" lets you make and hear repeating rhythms with multiples to simulate the metronome activity above (with multiples of 3 and 4). http://www.philtulga.com/unifix.html See also Phil Tulsa's "Sequencing with Fibonacci" to hear paired rhythms with multiples of 2 and 3, 3 and 5, and 5 and 8 - http://www.philtulga.com/PatternActivities.html#01
- "Interactive Hundred Square" is an online activity for comparing multiples of different numbers on a hundreds square: http://www.hellam.net/maths2000/100square.html

TO THINK ABOUT AND DISCUSS

- See the "Think About It" questions at the end of the student activity.
- Ask students why they think there are 60 minutes in an hour or 24 hours in a day.

Multiple Patterns

WHAT DO THESE NUMBERS HAVE IN COMMON! SEE FOR YOURSELF!

GOAL

Create and use colorful patterns to compare the multiples of two or three numbers.

PLAN

Here's what you'll do in this activity:

- To set up the activity:
  - Create three sliders for selecting the multiples you want to explore.
  - Hatch a turtle, give it the shape of a colored line, and write a procedure for it to stamp colored lines at intervals determined by one of the sliders.
  - Position the turtle at a starting point near the left edge and program a color to stop turtles when they reach the right side of the project page so they don't "wrap."
  - Customize two more turtles to stamp colored lines at intervals determined by the other two sliders.
  - Create a procedure and button to move all three turtles at once.
- To use the activity:
  - Study the patterns of the stamped lines to see where two or more colors line up. These indicate common multiples.
  - Explore different sets of two or three multiples.

T Coin Flipper

TEACHER NOTES

OBJECTIVES

Set up a project for conducting coin-flipping experiments and recording the outcomes. Analyze data as the computer repeatedly flips a virtual coin.

CONTENT STANDARDS ADDRESSED

- DATA ANALYSIS AND PROBABILITY
  - predict the probability of outcomes of simple experiments and test the predictions
  - use proportionality and a basic understanding of probability to make and test conjectures about the results of experiments and simulations
  - collect data using observations, surveys, and experiments
  - represent data using graphs

Duration: 1 - 2 class periods

BEFORE YOU START

- Students should be familiar with the MicroWorlds EX environment and with writing procedures.
- Help students locate the folder from which they will import the *Pie-Grapher* turtle.

NEW MICROWORLDS EX TERMS AND SKILLS

Skills:

- importing a loadable turtle
- changing the value of a turtle's variable under program control
- changing the contents of a text box with **set**___

Terms: setsh, run, pick, list, clickon, clean

RELATED EXPLORATIONS

- Flip a coin 10 times, recording the number of heads and tails. Pool data from other members of the class. Compare the data to the computer's data. Which data is closer to 50-50? Why?
- Visit the Coin Flipper at www.mathcats.com/microworlds/coinflipper.html. Flip a virtual coin 100 times and look for the longest string of heads or tails in the record of the flips. Repeat several times.

TO THINK ABOUT AND DISCUSS

See the "Think About It" questions at the end of the student activity.

Coin Flipper

HEADS I WIN, TAILS I LOSE - WHAT ARE THE ODDS OF THAT? LET THE MICROWORLDS COIN FLIPPER HELP YOU FIGURE IT OUT!

GOAL:

Collect, record, and analyze data as the computer repeatedly flips a virtual coin.

PLAN

Here's what you'll do in this activity:

- To set up the activity:
  - Import a special turtle for drawing pie graphs, and set its size and position.
  - Create the objects you'll need for the activity: a “coin” turtle that can switch between heads and tails shapes, two text boxes for recording the number of heads and tails, and a slider for setting the number of coin flips.
  - Write procedures for flipping the coin, graphing the results, and resetting the pie graph and text boxes.
- To use the activity:
  - Make predictions and run coin-flipping experiments with large and small numbers of coin flips. Analyze the results.

T Division Machine

TEACHER NOTES

OBJECTIVES

Create a "division machine" which converts fractions to decimals and to long division answers with remainders. Use the division machine to explore repeating decimals and to compare fractions, decimals, and long division problems.

CONTENT STANDARDS ADDRESSED

- NUMBER AND OPERATIONS
  - understand various meanings of division
  - recognize equivalent representations for the same number
  - understand the meaning and effects of arithmetic operations with fractions, decimals, and integers
  - develop and use strategies to estimate the results of whole-number computations and to judge the reasonableness of such results

Duration: 1 class period

BEFORE YOU START

- Students should be familiar with creating sliders and writing procedures.

NEW MICROWORLDS EX TERMS AND SKILLS

Skills:

- changing the contents of a text box with **set**___

Terms: int, /, remainder

RELATED EXPLORATIONS

- To introduce the activity, ask students to turn 1/3 into a decimal by dividing 3 into 1. Then ask them to write this fraction as a long division problem with remainder. Repeat for 23/11.
- Use the Division Machine to check the accuracy of mental estimates involving division.

TO THINK ABOUT AND DISCUSS

- In what real-life situations does it make more sense to think in terms of fractions or ratios? decimals? long division quotients with remainders?
- Have students use the Division Machine to explore repeating decimals. Set the numerator to 1 or a low number. Ask students to look for, record, and predict patterns as the numerator or the denominator increases.
  For example: Compare 1/7, 2/7, 3/7...
  Compare 4/3, 5/4, 6/5...
  Compare 1/2, 1/3, 1/4, 1/5...
  Compare 1/3, 2/3, 3/3, 4/3, 5/3...
  Which denominators produce repeating decimals?

Division Machine

WHAT IF YOU HAD A DIVISION MACHINE THAT COULD GIVE YOU INSTANT ANSWERS? HERE'S HOW TO BUILD ONE!

GOAL

Create a Division Machine that converts fractions to decimals and to long division problems with remainders. Use the Division Machine to explore fractions and to check mental estimates.

PLAN

Here's what you'll do in this activity:

- To set up the project:
  - Create the objects you need for the Division Machine:
    - two sliders for setting the numerator and denominator, with a line separating them;
    - a text box for displaying the fraction as a decimal;
    - four more text boxes and a long division symbol to display the fraction as a long division problem.
  - Write a procedure to divide the numerator by the denominator and place the results into the various text boxes. Then create a button to run the procedure.
- To use the project:
  - Explore with the Division Machine: make mental estimates and see how close you are to the actual answer. Experiment to find repeating decimals.